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MANUAL

OF

ANIMAL AND VEGETABLE PARASITES.

ON

ANIMAL AND VEGETABLE PARASITES

OF THE

HUMAN BODY,

A MANUAL

OF THEIR

NATURAL HISTORY, DIAGNOSIS, AND TREATMENT.

BY

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TRANSLATED FROM THE SECOND GERMAN EDITION, BY

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VOL. II.

ANIMAL PARASITES WITH STRIPED MUSCULAR FIBRES AND VEGETABLE PARASITES.

WITH SIX COPPER-PLATES.

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CONTENTS OF VOLUME II.

ANIMAL PARASITES.

EXPLANATION OF THE PLATES.

ANIMAL PARASITES.

PLATE (TAB.) VIII.

(This Plate, and the explanation of the figures 1 to 10, are given in the first volume.)

Fig. 11—13. *Linguatula ferox* = *Pentastomum denticulatum* (Zenker's), completed according to my comparative examination.

,, 11. *Linguatula ferox* (complete).

a. Chitinous oral ring.

,, 11. *b.* Apparatus of hooks at rest.

γ. Covering of the point.

c. Intestine.

d. Clearer spot, possibly an opening on the abdominal surface.

e. Anus.

f. Rows of hooks.

g. Rows of pores between the last.

,, 12. Isolated apparatus of hooks.

a. The peculiar claw or hook.

b. Chitinous base which bears this hook.

c. Thread or flap which supports the covering of the point *d.*

α. Hypomochlion of the base of the hook *a*, by which it is balanced in the fork *b.*

β. Free end of the base of the hook.

γ. The base of the hook, which, in gliding in and out, presses away the covering of the point.

,, 13. Hook apparatus in action. The covering of the point *d* has lost the point of the hook *a.*

,, 17. *Linguatula* (*Pentastomum*) *constricta* (of Siebold), after Bruner.

,, 18. The same, after more recent drawings, by Bilharz.

,, 19. An isolated hook of this animal, after the same.

,, 20. Magnified view of his head cut off, with the mouth and its four hooks, after the same.

Figs. 14—16. *Acarus folliculorum.*

Fig. 14. A young, six-legged animal, after Simon.

,, 15. An eight-legged specimen, after Simon.

a, a. Papillæ on the side of the mouth *b.*

c. The feet with three bristles or claws delineated on the free ends.

Fig. 16. Still more mature, eight-legged example. The bases supporting the feet and the hook in the centre of the free ends of the feet. The two side-hooks of Simon are not true bristles or hooks, but the projecting points of the half moon-shaped free ends of the feet, as is still more clearly represented in fig. 16′ *a*.

PLATE IX.

Figs. 1—7. Itch mites, after Gudden.

Fig. 1. Female viewed from the back.

„ 2. „ „ abdomen.

„ 3. Male viewed from the abdomen.

„ 4. Group of mites, with eggs in various stages of development.

„ 5. Cast-off skin, remaining behind in a passage after the first moulting.

„ 6. Six-legged mite, as, in order to moult, it conceals itself in its gallery, and draws near to it masses of particles and repairs itself in quiet.

„ 7. Eight-legged mite, which has just moulted in the gallery.

„ 8. *Leptus autumnalis*, after a drawing kindly given to me by Prof. Leuckart.

„ 9. Male louse from the head, with the system of tracheæ and the respiratory stigmata.

Fig. 9 *a*. Termination of the head and working apparatus.

„ 9 *b*. An isolated and magnified antenna.

„ 10. Female body louse.

„ 11. Its masticatory apparatus.

„ 12. Egg of a louse, found on the hair of a Peruvian mummy. The cover has unfortunately been neglected to be drawn. The description of the cover of the egg of this louse is found in the text in the place relating to it.

„ 13. Female louse, with the system of tracheæ, and the two muscles moving the hooks of the second and third pairs of feet at *a*, which give the last joints the appearance of a bell.

„ 14. Head of the flea.

„ 15. His double, at first spirally wound-up penis.

Figs. 16—18. Larvæ of the Gad-Fly of *Cervus Capreolus*.

Fig. 16. The same larva seen from the abdominal side, and magnified. *a*, kind of depression, in which the anal aperture opens.

b. The four bundles of muscles which shine through the body of the larva, and *cc*, two small brown valves.

„ 17. The same, seen from behind. On the head is seen two small, scarcely perceptible dark brown hooks, also the fine prickles on the segments, and a dark spot on the rounded-off back part of the tail.

„ 18. A piece of a trachea with the little valve still fastened on it.

VEGETABLE PARASITES.

PLATE (TAB.) I.—ALGÆ.

Fig. 1. *Cryptococcus Cerevisiæ*, discharged from the stomach of a patient during vomiting.
- *a, b, c.* Young germs adhering to the mother-cells.
- *d, e.* Particularly distinct nucleus, or the internal vesicle.
- *f.* The same from beer.
- *g.* The same from diabetic urine. (Robin.)

,, 1'. *Cryptococcus guttulatus*, from the intestinal canal of graminivora, sometimes found in the human intestines.
- *a.* An isolated specimen.
- *b.* Two associated cells.
- *c.* A large cell, with a small one on its side.
- *d, e.* Larger and more advanced stages. (Robin.)

,, 2. *Merismopœdia Ventriculi* = *Sarcina*, discharged by vomiting.
- *a.* Prismatical or cubical masses, divided by four furrows.
- *d.* The same united by means of amorphous connective substance.
- *g.* The same, representing an irregular mass.
- *h.* Ditto, but with cells which only show two divisions.
- *i.* Round or oval isolated cells, with 2 or 3 granules.
- *l, m, n, o.* Without a nucleus.
- *p, s, v.* Coloured masses, *q*, with ovoid elongated cells } Robin.
- *k, y.* Blood coloured cells, with mixed substances } Robin.

,, 3. *Leptothrix buccalis.* In the scraped-off coat of the tongue, bodies commonly found with a central epithelial substance (epithelial processes) from the papillæ of the tongue, with enveloping granular masses and thread-shaped fungi on the periphery. (Wedl.)

,, 4. *Leptothrix buccalis*, with oral mucus from the coating of the tongue, with epithelial cells (*a*), mucus globules (*b*), granules and elements of Algæ (*c*). The same free in saliva (*h, h*).

,, 5. *Leptothrix buccalis.* From the ordinary coating of the tongue.
- *a.* Thallus of bundles of filaments.
- *b.* Bundle of filamentous fungi themselves; amongst both, fine root-shaped corpuscles without transverse partitions.

,, 6. Larger bundle of this plant from the tartar of the teeth, implanted in fine granular masses (*a*). A little full of roots with fine corpuscles (*b*). (Fig. 4—6 after Robin.)

,, 7. *Leptomitus Hannoveri*, from ulcerated mucous membrane of the œsophagus, and from typhus patients. (Robin.)

,, 8. Ramifications of the same.

,, 9. *Leptomitus* of Gubler, from a severe shot-wound in the palm of the hand.
- *a b, d.* Single or ramified, articulated filaments.
- *c, c.* Spores always associated in two. (Robin.)

Fig. 10. *Leptomitus Uteri* of Lebert.
a, a. Mycelium tubes without partition-walls.
h, h, h. With partition-walls.
e, e. Fine granules in the interior of the cells.
b, d, f, g. Spores in various conditions.

PLATE (TAB.) II.—A. ALGÆ.

,, 1. Wilkinson's Alga.
a, a. Two primary filaments, which divide into secondary ones.
c. A flask-shaped swelling on the one end of the filament.
c'. The same in the middle of the filament. (Sporangium ?)
d. Round bodies with broken secondary filaments.
,, 2 and 3. Hannover's Algæ in the eye.
a. Corpuscles with and without nuclei after treatment with acetic acid.
a'. Corpuscle with a smaller nucleus proceeding from it.
b. The filaments treated with acetic acid, their outline resembles certain fresh-water Algæ.

B. FUNGI.

,, 1. Malmsten's *Trichophyton tonsurans.* Hair covered with spores.
,, 2. The same, isolated rows of spores.
,, 3. Hair with spores from a Plica Polonica.
a. Spores breaking out from the hair.
b. The same enlarged. (Gunsburg.)
,, 4. Hair-root with the fungus, of which some break through the hair. (Gunsburg.)
,, 5. Contour of the hair with the fungus *a*, and breaking up of the hair *b*. (Gunsburg.)
c. Spores on the epithelium cells.
6. Hair after Hebra-Wedl much split up.
a. Spores with bright granules, in groups on the hair.
b. Shorter, bifurcating Thallus thread.
,, 7. Champignon des ulcères from Lebert, found in a crust of pus.
a, a. Small sporules.
b, b. Sporules with granules.
c, c. Rows of spores.
e, e. Molecular granules. (Lebert, Atlas XXII, fig. 7.)

PLATE (TAB.) III.

,, 1. *Microsporon mentagrophytes,* after Gudden-Beyer. Slender filaments, with spores variously arranged.
,, 2. Ditto, thicker threads, with partition-wall.
,, 3. Ditto, more enlarged, without partition-walls.
,, 4. *Microsporon furfur*, after Wedl.
a. Spores with bright oily nuclei.
b. Projecting from a longer process, two spores melting away.
c. An accumulated group of spores.
d, d. Spores arranged like a rosary for a shorter extent.

Fig. 5. Hair with Favus Fungus: *Achorion Schönleinii.*
a, b. Groups of spores projecting on the surface of the hair.
e, c, i. Rows of spores, which anastomose or appear on the surface of the hair.
d. Special forms of spore.
e, f. Spores on the broken-up root of the hair.
g, h. Broken-up root of the end of the hair with spores amongst the lamellæ.
„ 6. Crust of skin taken from the neighbourhood of a favus crust.
a. Opening in the skin of a sebaceous gland, or of a fine hair-follicle.
b, f. Spores adhering to the lamellæ of the skin.
„ 7. Favus crust of the natural size.
a. Small favi, four in number, each penetrated by a hair.
b. The same seen from beneath.
c. A crust with concentric layers penetrated by three hairs.
d. The same seen from beneath. (Fig. 5—7 after Robin.)
„ 8. Network of threads of the thallus of achorion, after Wedl.
„ 9. The same spores in various forms, after Wedl.
„ 10. *a, b, c.* Various thallus threads, after the same.
„ 11 *a.* Transverse section through the middle of a small crust of favus, four times magnified.
b. Spores germinating on an apple. (Remak.)

PLATE (TAB.) IV.

„ 1. A hair from a favus treated with alkali, and with gas in the interior.
„ 2. The same with thallus threads (450.) (Wedl.)
„ 3. Thrush-fungus = *Oidium albicans.*
a. Fragment of a separated thrush layer implanted in masses of epithelium.
b. Spores.
d. Thallus threads with partition-walls.
e. The free end of a thallus thread somewhat swollen.
g. The same as before with constrictions, without partition-walls.
„ 4. Part of an aphthous crust cut off on the third day of the disease, formed of epithelial cells and masses of spores proceeding from a single thallus.
„ 5. Perfectly developed thallus threads of *Oidium*, with partition-walls and constrictions (*a, a*), which at the end of the tubes become coarser (*b*), with fine granulations (*c*), and in parts ramifications (*d*), and with small fresh branches. The origin of the thallus is situated sometimes in a spore heap (*b*), and begins from an elongated spore (*g*), the free end is sometimes swollen (*i*) and previously notched (*k*). Spores, which germinated on a piece of aphthous membrane preserved on a moistened glass (*h*).
„ 6. Ends of perfectly developed thallus threads (460).
„ 7. The same under a higher magnifier (780).
„ 8. Filaments with granulating cells (*a*), and without granulations (*b, c*), from the aphthous membrane of an adult. (Fig. 3—8, after Robin and Wedl.)

PLATE (TAB.) V.

Fig. 1. Wedl's fungus, from the vomited matters of Dr. Herzfelder's patient.
a. Thicker thallus threads.
b. Thinner thallus threads.
c. Three threads proceeding from one cell.
d, e, f. Club-shaped primary cells with thallus threads.
g. Stretched cells of a thallus thread, with nuclei inside towards the junction of the articulations.

„ 2. Bennet's fungus, from the expectoration in a case of pneumothorax.
a. Branches with spores.
b. Articulated spores.
c. Spores of various forms.
d. Granulated mother-soil.

„ 3. Mayer's fungus, from the external ear.
a. Simple, not swollen, internally granulated filaments.
b. Developed fungus, with spores on its capitulum.

„ 4. Meissner's nail-fungus.
a. The claw-like, curved, degenerated nail.

„ 4′. *a.* Articulated filaments.
b. Sporangia.
c. Spores.

„ 5. *Mucor mucedo.* Observed by Sluyter in a cavity in the lungs.

„ 6. *Puccinia Favi* (Ardsten), after Robin.
a, d. Normal forms.
b. Mass enveloping the fungus.
g, h. Abnormal forms.
k. Puccinia Virgaureæ.

„ 7. Fungus of *Pityriasis versicolor* treated with concentrated sulphuric acid and *Syrupus Rubi Idæi.*

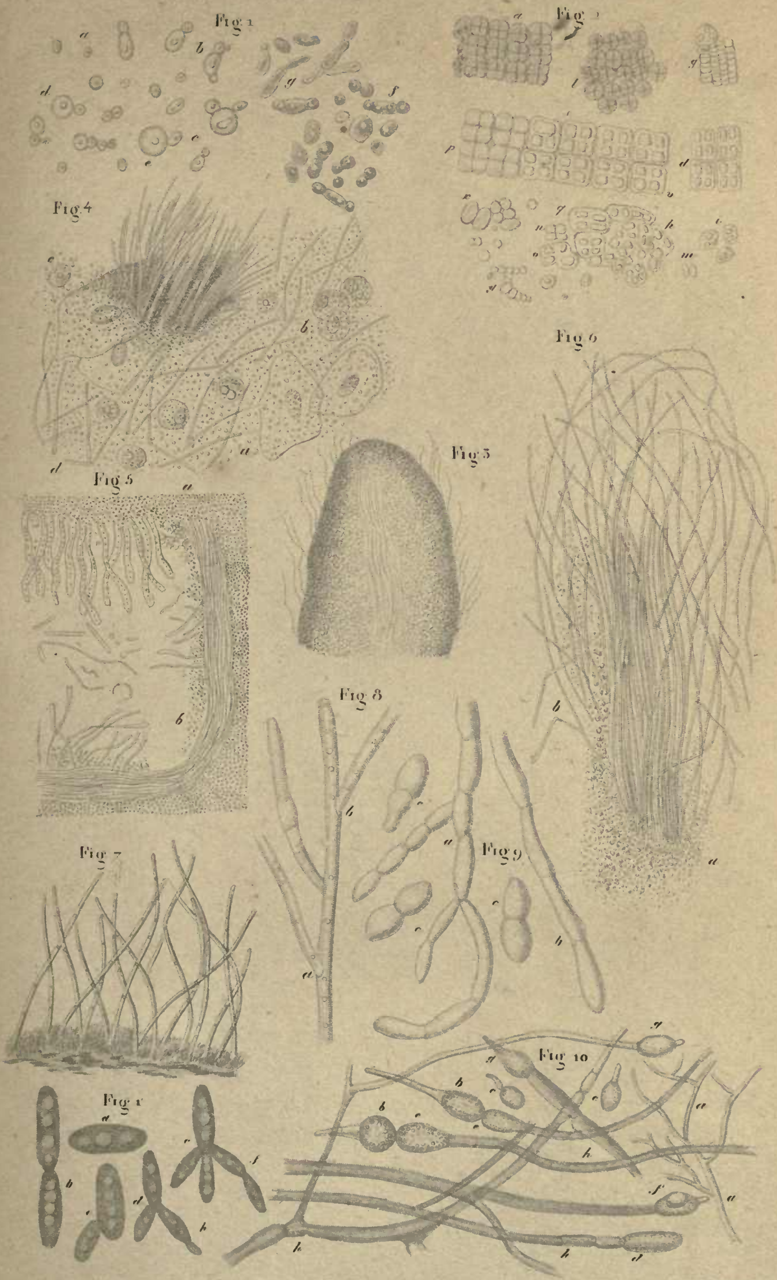
„ 7′. Copy of the termination of a filament, after Gudden.

„ 8. Parasite found upon the inflamed vagina of a diphtheritic female, by Professor Greuser (sent by Dr. Zenker, of Dresden). The spores and articulated filaments are represented.

Tab. IX

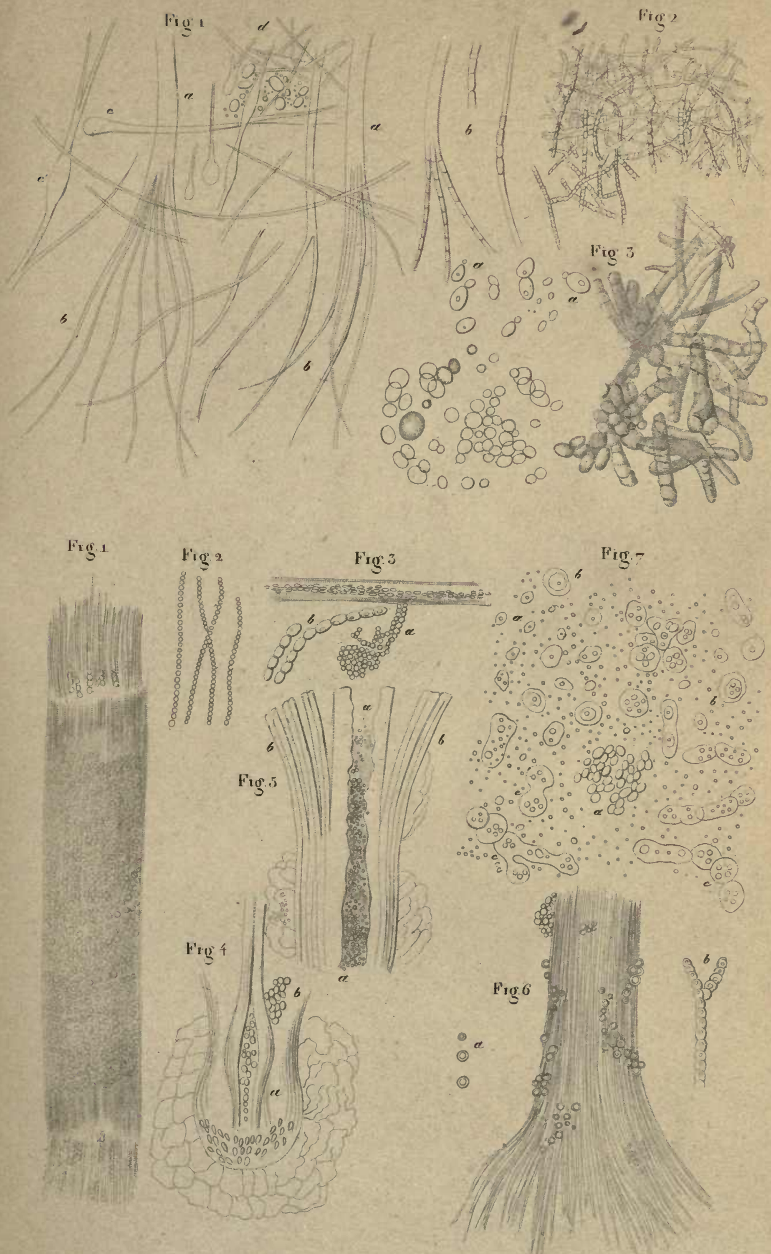

Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8
Fig. 9
Fig. 9a
Fig. 9b
Fig. 10
Fig. 11
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Fig. 17
Fig. 18
Fig. 19
a
b
c
d

Tab I



C. Loedel sc

Tab II



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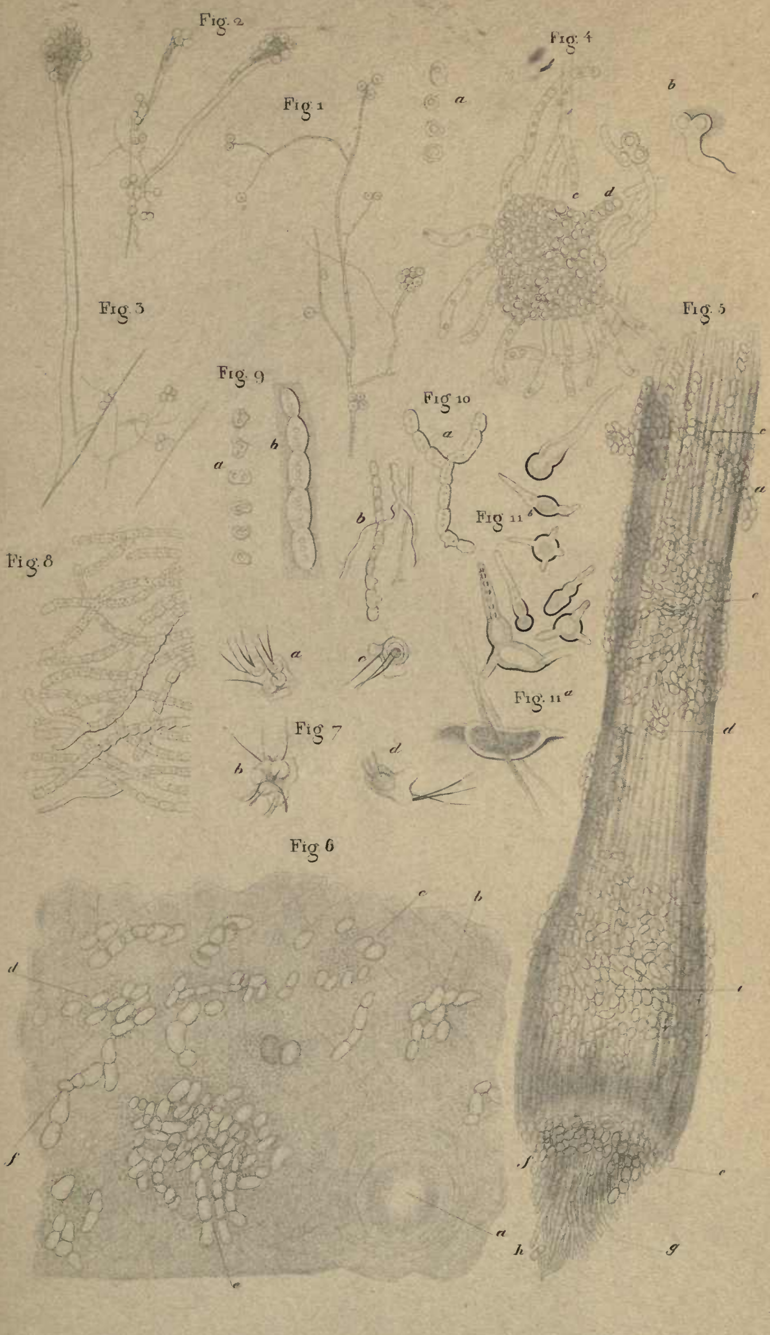
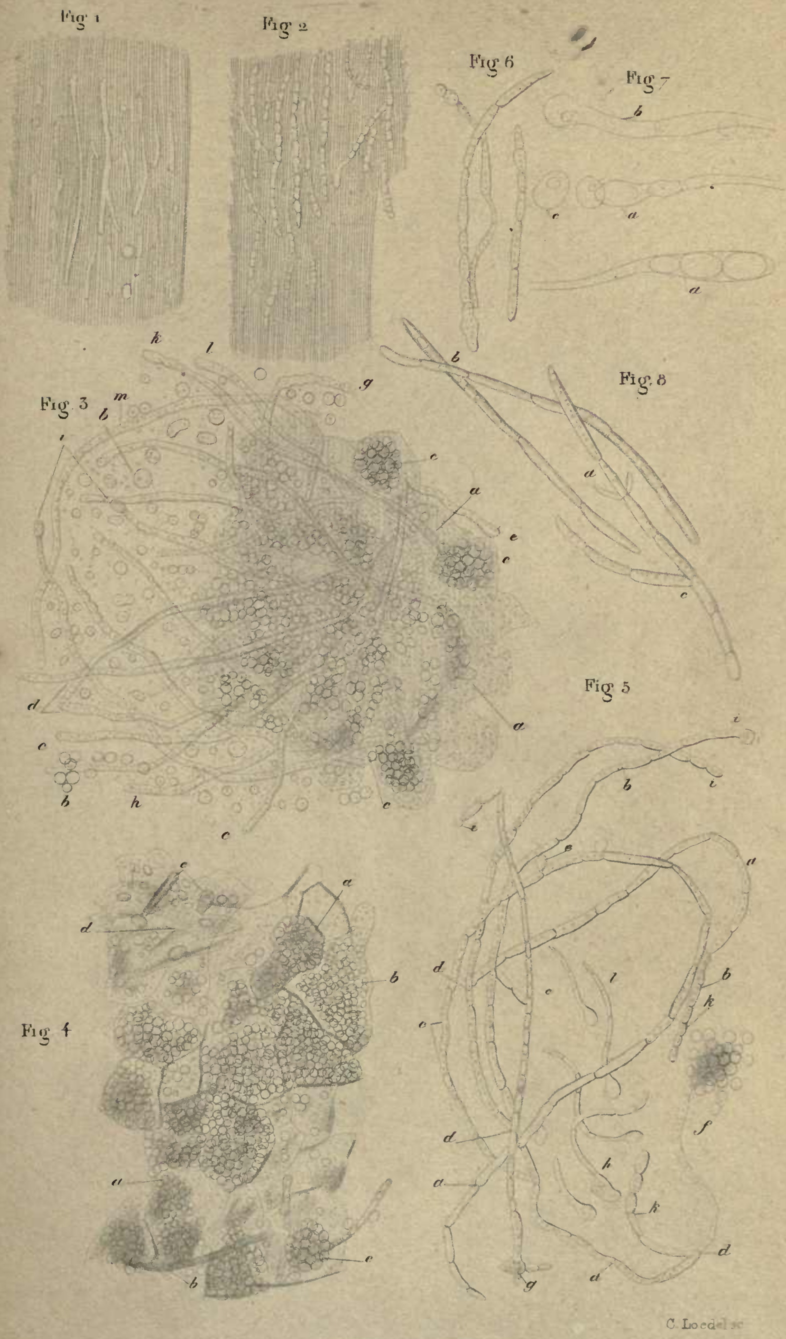


Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig 6
Fig 7
Fig. 8
Fig. 9
Fig 10
Fig 11 b
Fig. 11 a

Tab IV



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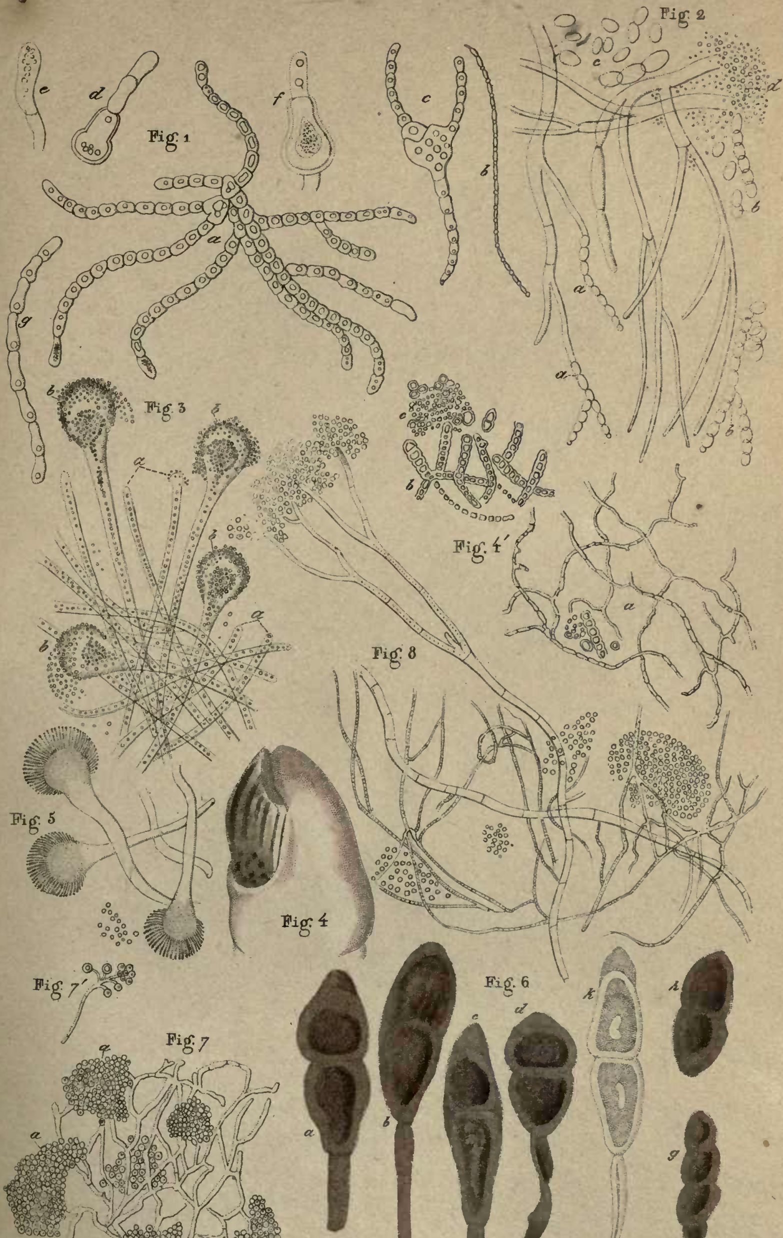
Tab. V



C. Loedel sc.

ANIMAL PARASITES.

SECOND GROUP.

PARASITES WITH DISTINCT TRANSVERSELY STRIATED MUSCULAR FIBRES.

First principal Division—ARTICULATA.

The articulate or jointed animals may be described after C. Vogt.

Articulata sunt animalia typum bilateralem quoad corporis structuram sequentia; symmetricam organorum positionem stricte observantia; organa motoria articulata et ex cavis interneque musculosis articulis formata, exhibentia, inque statu embryonali vitellum, embryonis medullæ abdominali ex diametro oppositum præbentia, ita ut embryo vitellum superficie dorsali tangat.

The Articulata exhibit the following peculiarities:

1. *The greatest symmetry* in the arrangement of the lateral and median organs.

2. *A transverse division of the body into several rings or zonites,* which in type stand near the Annelidous worms.

3. *A dissimilar segmentation in different regions of the body,* which allows us to distinguish, sometimes head, thorax, and abdomen, sometimes only an abdomen and a head and thorax fused together (*Cephalothorax,* in spiders and crabs), sometimes only a body amalgamated into a single piece (mites).

4. *A knotted nervous cord laid upon the inner wall* (not at the back as in the Vertebrata) which forms an œsophageal ring by

commissures with the cephalic ganglion. The more distinctly the articulation is marked, the more regular is the formation of ganglia; the more indistinct the former, the greater is the fusion of the ganglia into larger masses.

5. *A tolerably complicated motor system.*—In the first place, a firm, hard skin, which forms hollow rings or tubes, in the interior of which the muscles are attached. Here, therefore, we have the organs of motion inclosed in the interior of the levers to be moved, whilst in the Vertebrata the muscles are fixed on the outside of the framework. And whilst in the lower animals we neither meet with articulated limbs nor with levers united by articulations, here we meet with limbs which consist of joints united by articulations (generally ball and socket or hinge joints), and serve in part for all sorts of movements upon the earth (hopping, running, springing), in water (swimming), and in the air (flying), in part for nutritive purposes, for the capture of prey and as assistants in mastication, and partly for the perception of the impressions of the senses. They allow the recognition of the following individual parts:

a. The antennæ.—They are sometimes double (an anterior inner and posterior outer), and sometimes single on each side, or apparently entirely deficient from being converted into biting or raptorial organs. They stand before and over the mouth upon the forehead; lower down in embryos, and only advancing upwards by degrees. They are divided into the *shaft* (*scapus*), which is usually composed of several joints, and the *flagellum.*

b. The oral organs, which serve for piercing the prey, for mastication, and closing the mouth, lie round the latter, and consist originally of four pairs of lateral jaws, the first of which is always, and the last generally, fused together into an operculum-like lip. In them the following individual parts may usually be distinguished: *α*, an *upper lip* (*labrum*); *β*, a pair of *upper jaws* or *mandibles* (*mandibulæ*), sharp, simple, consisting of a single powerful piece; *γ*, a pair of *lower jaws* or *maxillæ* (*maxillæ, mâchoires*), which usually consist of a *shaft* or *body* (*stipes*), a *lobe*, destined either for mastication or concealment, and an external *feeler* or *palpus*; *δ*, a very composite *lower lip* (*labium*).

c. The masticating feet or *foot-jaws* (*pates-mâchoires*), which form a transition between the organs of motion and nutri-

tion, are wanting in the Insects; they occur principally in animals with a cephalothorax, and are in three pairs.

d. The *true legs* = feet (*pedes*) at least in three pairs, consisting of a globular or cylindrical *hip-joint* (*coxa*); the *trochanter*, which is immoveably soldered to this; the *thigh* (*femur*), the *shank* (*tibia*), and the multi-articulate *foot* (*tarsus*).

e. The *false ventral* or *abdominal feet* (*pedes spurii, fausses-pattes*) on the segments of the abdomen, behind the true legs. They are wanting in the Arachnida and Insects.

f. In the higher species, the jointed appendages upon the back, the *wings*. *Cilia* are entirely deficient.

6. *A peculiar course of development.*—A clear distinction is produced between the yelk and the germ-foundation from which the embryo is formed, which is turned with its back towards the yelk, and not with its ventral surface as in the Vertebrata, and the organs of which are developed from the ventral side and finally close towards the back.

The *Articulata* are divided into four classes: I, *Crustacea;* II, *Myriapoda;* III, *Arachnida;* and, IV, *Insecta,* of which we are only interested in the last two.

A. Class I. Arachnida.

Arachnida sunt Articulata inprimis cephalothoracica; in cephalothorace, non in abdomine pedes, plerumque 8, *gerentia et antennis veris, quarum functiones per mandibulas aut forcipes venenatorias exhibentur, carentia.*

We find only a cephalothorax with four, rarely with three segments, or a single fused mass with oral organs; with four pairs of legs on the middle of the body; with the anus and sexual orifice on the abdomen.

In detail the Arachnida consist of the following parts:

1. The *skin* consists of a soft, coriaceous, rarely brittle, extensible, but not contractile, chitinous mass. It is rarely naked, generally hairy, bristly, scaly, or furnished with jointed appendages, and also with pigment-granules or vesicles.

2. The *legs* consist of a roundish *coxa* with a short *trochanter*, a powerful *femur*, a long *tibia*, and generally a two-jointed *tarsus*, with or without claws. In the mites, the sections are generally of equal size; in the weaving spiders, the tarsal joints

are extremely numerous. The hinder three pairs are usually similar; the anterior is rather a foot-jaw. The last tarsal joint bears one or two claws, or a pedunculate adhesive lobe (in the mites), or internally a sort of comb or a series of bristles (weaving spiders).

3. The *oral organs* vary greatly. The principal weapons are the *antenneal jaws,* which are of the form of a knife, dagger, or scissors, or furnished with a thick process with a sharp claw. Behind these are the scissor-like or many-jointed *maxillæ,* with very slightly developed palpi at the base, and, beside these, soft, puffed, sucking lips. In the mites, these oral organs stand upon an elongated proboscis with a thick base.

4. The *nervous system* in the majority is much fused together. The mites have only a ventral ganglion with a simple œsophageal band, and without cephalic ganglia; the spiders have a cephalic ganglion, an enormous thoracic ganglion, and a ventral ganglion, which is usually small, but rarely deficient; the scorpions have a ventral chain of ganglia.

5. The *organs of the senses* usually consist only of simple eyes, to the number of 2—5, seated laterally or in groups upon the cephalothorax or upon the back. The optic nerve is dilated into the form of a beaker, and surrounded by dark pigment membrane; the vitreous body is globular, and the *cornea* roundish. Some of them are blind. The true spiders appear to possess the senses of hearing and smelling.

6. The *intestine* is divided into a thin, horny, subsequently muscular, œsophagus, and a straight intestine, opening behind, without a stomach (scorpions and Crustacea); or the same parts occur with a stomach and all sorts of cæcal appendages, which often distribute themselves through the whole body, even into the palpi and claws (the other Arachnida); *salivary glands,* a *liver,* in the form of a granular coat of the intestine, or large lobate masses, and *urinary organs,* as thin branched tubes, are present.

7. The *organs of respiration* are wanting in many of the lower forms; in the higher ones they are delicate branched *air-tubes,* with stigmata arranged in pairs, or flat *air-sacs,* which receive the air through an opening in the belly, and in their interior contain a number of plates, like the leaves of a book (that is to say, a series of compressed tracheal stems).

8. The *circulatory organs* present a tubular, many-chambered heart, from which arteries are given off; they only occur where the respiratory organs are developed.

9. The *venomous organs,* which are rarely deficient here, are pairs of twisted glandular tubes, which lie and open in the claws of the antenneal jaws in the head, and only in the caudal style of the scorpions. Probably only the wounds of scorpions are fatal to man; the utmost that any other Arachnidan can do is to produce a little fever or local irritation, as for example, the Tarantula and Malmignatte.

10. The *sexual organs* in the *female* are racemose or tubular ovarian sacs, lying anteriorly in the abdomen, with short oviducts opening into the *vagina,* and at the orifice of this, with two horny seminal pouches and an ovipositor. The sexual organs of the *male* are still very little known. The testes are convoluted, glandular cæca, or racemose vesicles, which open at the extremity of the abdomen. The mites and geometric spiders have a long, horny penis, spines, and a clasping apparatus. In the true spiders the palpi are thickened, and have a spiral thread and horny pieces (hooks, cups, or saucers) in and upon them, with which the males take up the semen and put it into the vagina.

11. Some *mites* and *scorpions* are viviparous; the other Arachnida lay roundish and often large eggs, with a germinal vesicle and simple germinal spot when within the oviduct. The germ-stratum gradually grows backwards over the yelk. The higher species change their skins without any metamorphosis; the lower ones with a simultaneous metamorphosis. Here the feet are at first undeveloped, without joints, or in smaller number (two or three pairs in mites), elongated, and swollen at the anterior part in the form of a button. After the first moulting the missing pair of feet makes its appearance. The young of the water mites pass into a pupa state during the moulting. *Linguatulæ* lose their feet in the later period of their life.

The Arachnida are divided into, 1, the *Spider-like,* in which there is always a distinct separation of the abdomen from the cephalothorax, or even of the head from the thorax and a cœcal intestine; the skin is soft; and, 2, the *Crustacea-like* with the skin hard, shield-like; the intestine straight; the palpi generally nipper-like.

Order I. Acarina (*Mites*).

Acarina sunt animalia parasitica, minima, simplicissima; capite, thorace, et abdomine in unicam massam confusis; pedibus in statu

immaturo 6, *in maturo* 8 *articulatis, formâ diversissimis, abdomini insertis, aut nullis* (*in Linguatulis maturis sine pedibus, in immaturis vero cum pedum incremento*) ; *cute magis minusve molli, tantum in Oribatidis* (plant-mites) *fragili, dura et fere vitrea ; organis manducatoriis formatis ex proboscide interdum articulata, re- et pro-tractili, in qua aculei* 2 *acuti et gladiformes reconditi sunt ; tubo intestinali proboscidem secuto, appendicibus multis et lateralibus instructo ; oculis* 2 *in anteriore cephalothorace, aut nullis* (*in Acaris sub cute parasitantibus*) ; *organis antennæformibus binis ad utrumque proboscidis latus, plerumque ex* 5 *articulis compositis, et formâ variantibus* (*exc. in Hydrachnidis aculei- aut ancoræ-formibus, aut valvæformibus, dentatis in Ixodidis, aut fusiformibus in Oribatidis, aut setosis in Bdellidis et Opilionidis. &c.*) ; *organis respiratoriis tubulosis, ramificatos fasciculos formantibus et ex stigmatibus* 2 *lateralibus, quæ plerumque interpedes posita sunt, exortis ; in inferioribus Acarinorum familiis nullis ; corde nullo. Parasita rarissime vivipara, plerumque ovipara ; in juvenili statu* 6 *pedibus instructa, ex quo in maturum statum* 8 *pedibus ornatum, tempore quodam in otio, sive nutrimento, et interdum in tenebris et cystidibus quibusdam peracto, transeunt.*

First Family—LINGUATULIDA = PENTASTOMA.

Synon : *Tænia ; Distoma et Porocephalus ; Tetragulus ; Echinorhynchus ; Halysis ; Prionoderma ; Polystoma et Pentastoma ; Monostomum.*

From these names it will be seen at once what various places in the system have been assigned to this worm. Rudolphi regarded them mostly as Trematoda ; Diesing places them with the worms, as *Acanthotheca.* We pass over his views, which have been completely refuted by Van Beneden, and refer them, with the latter, to the Articulata, on account of their transversely striated muscles.

Animalia solitaria, alia mascula, alia feminea ovipara. Corpus vermiforme, elongatum, depressum vel tereliusculum, ex articulis permultis compositum, læve vel fimbriatum seu aculeatum ; caput corpore continuum, fere cephalothoracicum ; os anticum, chitinosum, ad cujus utrumque latus hamuli bini aut semilunares, aut unguiformes, simplices aut magis compositi, in exemplaribus juvenilibus ad pedes breves, fere inarticulatos affixi, in exemplaribus maturis

in rimas (quas Diesing injuria bothria rimæformia uniserialia nominat) retractiles, ita ut ad cutem abdominalem ipsam affixi sint; præterea stigmatum series inter annulos vel inter fimbriarum series in cute (respiratoria organa). Tractus intestinalis simplex, hinc ore, illinc ano terminatus. Systema nervosum constans ex ganglio pectorali, seu subœsophageo, crasso; annulo œsophageo completo; interdum 4 gangliis abdominalibus, ex 2 filis nervosis parallelis, catenam nervosam articulatorum exhibentibus exortis. Systema vasorum ex Diesingio adest. Penis filiformis, simplex infra os ex Diesingio, duplex in superficie abdominali (ex aliis); testiculus simplex; ductus deferentes 2. Apertura feminea in apice caudali, vesiculis copulatoriis magnis, spermatozoidia gerentibus.

Embryones Crustaceis Lernæidis (ex. c. Anchorellis, aut Pycnogonis) aut rectius Acaris similes.

For the last reason I have, with Vogt, referred the *Linguatulæ* to the *Acarina;* Van Beneden places them close to the *Acarus folliculorum,* as the lowest section of the Arachnida, but not both in one and the same order.

To me it has long appeared as though the *Acarus folliculorum* was a *Linguatula,* a view, however, which was combated by Van Beneden, when I asked for his opinion on the subject. Be this as it may, the relationship between the *Linguatulæ* and the *Acarus folliculorum* is extremely close.

As I refer the *Acarus folliculorum* to the order *Acarina,* I will do the same with the *Linguatulæ,* which, as the figure shows, are very similar to the *Acarus folliculorum,* even in the annulation of the abdomen, and, with Vogt, treat the two close together as nearly allied families.

Deceived by the roundish appearance of the foot-claws, which in certain positions almost form a closed chitinous ring, which certainly, on a superficial glance, has nearly the aspect of a mouth, and by the mobility of these ring-claws, people took these four feet for the same number of oral orifices, so that counting in the true mouth, five such openings were obtained, and the animal received the name of *Pentastomum.* Reckoning Bilharz's species, we are now acquainted with thirteen in all. Their number, however, would be still further reduced, if *Linguatula senata, denticulata, emarginata,* and *tænioïdes* belong to one species. In the mature fully developed state, these animals live in the frontal sinuses and lungs of Mammalia, or in the lungs of various lizards and snakes, but in the immature and encysted state in the

interior of very various parenchymatous organs, perhaps to undergo a change of skin there, but perhaps also to be swallowed in the encysted state by other animals, in the lungs or frontal sinuses of which they first attain their maturity, as Gurlt and myself suppose. For instance, *Linguatula denticulata,* which, perhaps, having immigrated mechanically into the nose of the dog which devoured the rabbit or other herbivorous animal infested by it, might become converted into *L. tænioides.* The entire cycle of existence of any species is still very imperfectly known, notwithstanding the endeavours of Van Beneden, who has done such high service with regard to the development and systematic position of these animals, and the good anatomical descriptions of Diesing. Very recently it has also been found that man harbours such *Linguatulæ;* but if, with Leuckart we regard those parasites observed in 1610 by Fulvius Angelianus and Vincentius Alsarius, which were expelled from the nose of a patient by sneezing, as a *Linguatula,* and not as the larva of a *Oestrus,* with the exception of this case, these animals have not been found free in the air-passages of the human subject, but in other places, either in the encysted state, or enclosed in cavities of the human body. We also know at present, both of the *Linguatula ferox* found by Zenker, and of the *Linguatula constricta* of Pruner and Bilharz, that in districts where *Linguatulæ* occurred in the human subject, the same two species also occurred in herbivorous domestic animals, or other indigenous Herbivora (as, for example, the giraffe).

1. *Linguatula constricta* ?, (*Pentastomum constrictum*? Von Siebold = Bilharz). (Tab. VIII, figs. 17—20.)

Corpus elongatum, cylindricum, annulato-constrictum, antrorsum rotundatum, apice caudali conico-obtusum, ventre planiusculum, cutis non aculeata. Long. 6‴, *Latit.* 1‴. *Habitat in hepati hominis nigritæ.*

Pruner found these parasites twice in negroes, on the hinder surface of the liver, on the mucous membrane of the small intestine (?), and on the mesenteric folds, in the form of white, chondroma-like, transparent, circular projections; or, in one case (in which he probably had to do with a fresh immigration and fresh

exudation) in the form of a larger, active vesicle, of the size of a kreutzer. Once the animal had slipped out of its vesicle and towards the duodenum. The tissue of the vesicle was elastic and strong, analogous to the serous membranes. On cutting the vesicle, the animal sprang easily out of it, and lived for five hours in water. According to Pruner, the animal, in its perfectly extended state, is fully 1″ long and 2‴ broad, cylindrical on the back, flat on the ventral surface, obtuse in front and pointed behind. Even with the naked eye, Pruner detected four protrusible and retractile hooks, which, under the microscope, are of a golden-yellow colour. The body was white, composed of rings, and the intestine yellowish green. On the notches between the segments, on the ventral surface, there were two rows of openings (*stigmata*). Moreover, Pruner saw, close to the intestine, two milky coils, on the left side in front, a projectile, bipartite, cylindrical organ, and on the lower surface of the intestine a delicate white filament, none of which he knew exactly what to make of. In the collection of Pathological Anatomy at Bologna, also, Pruner found two similar parasites obtained from the human liver.

Bilharz repeatedly found the animal encysted in the livers of negroes. Here and there, under the coatings of the liver, he met with capsules of the size of a grain of millet, which were filled with calcareous contents, and only two (?) colossal hooks. Very recently, Bilharz again found specimens of this parasite in the liver of a negro, encysted in the liver, of which he sent one capsule with the animal to Von Siebold. Its form and size agree with Pruner's figure. The capsule is firmly amalgamated with the parenchyma of the liver, consists of ligamentous tissue of its host, and is attached so closely to the animal, that, as Pruner said, the form of the animal is printed in it. The animal is at the utmost 6‴ long and 1‴ broad, as Pruner has represented it; it is cylindrical, with a sole in the middle of the ventral side, conical behind, obtusely rounded off in front, flattened from above downwards, separated from the trunk by a neck-like constriction, and strongly ringed. On the trunk the segments form broad bands, and are separated from each other by strong constrictions. Anteriorly, the latter gradually become smaller and shallower, but extend even up to the head. Small warts make their appearance on the periphery of the head. The hooks are similar, strong, not unlike the thorns of rose-bushes,

cat's claws, hollow internally, and of a yellowish colour. Although cut out, the animals lived nearly a whole day, and crept about, extending and contracting themselves. At the conclusion of this latest report, Von Siebold says that he has found everything as Bilharz described it.

This unfortunate parasite, in the short time that we have been acquainted with it, has seen a great variety of fates, and although one would have supposed that it would have been exactly investigated when it came under the hands of a Von Siebold (and Von Siebold established a new species upon it), yet its description by Bilharz and Von Siebold is extraordinarily defective, so that the note of interrogation which I have placed after *constricta,* will appear perfectly just to the unprejudiced, for whom alone I write. As regards Pruner, in the first place, he has been brought in a manner to a recantation with respect to the statement of size (fully 1″). And yet I believe that Pruner has given the size correctly. In his recantation, he has forgotten that his parasite had lain in water, as may be seen clearly in his account. In this it was considerably dilated, and he only measured the parasite in this swollen state. Hence the different statements of this author at different times as to the size of the worm.

Von Siebold founds the distinct species, and his assertion that we have not to do here with a *Linguatula ferox seu Pentastomum denticulatum* (which is the second species of Zenker, without any dispute, and was recognised as such, not only by Zenker and myself, but also by Van Beneden), upon the circumstance that *Linguatula ferox* is spined, acute at the extremity of the abdomen, and smaller, but that *L. constricta* is not spined, obtuse at the end of the abdomen, and larger. I also regard it as possible, nay, even probable, that there is a peculiar species of *Linguatula* in the South, which also attacks men; that we have to do with a peculiar immature and young state of another *Linguatula.* But if Herr Von Siebold wishes that the unprejudiced inquirer may form an opinion for himself, he should at least take care that the opinion that a *Linguatula ferox* is referred to, should not, first of all, be smuggled in under his shield. "Those are certainly my hooks" (*Das sind ja meine Haken*) cried Bilharz, on reading Kauffmann's dissertation upon *Pentastomum denticulatum,* as Von Siebold tells us in emphasised print. But then Von Siebold might have stated, or have got himself informed by his pupil Bilharz—1, *how large the hooks are,* upon which we have no

information, and the number of which we only know from the figure; 2, whether the hooks have an apparatus of support, such as the apparatus described by me, and afterwards by Zenker, in the *Linguatula ferox* of the rabbit, and clearly recognised by Van Beneden; 3, whether the points of the hooks have or have not a cover? From these points alone can we obtain distinctions adapted for the determination of species. If Von Siebold had enlightened us in this fashion, he would have spared the careful Zenker his doubts, and himself that invidious remark at page 331 of the seventh volume of his 'Zeitschrift.'

2. *Linguatula ferox* = *Pentastomum denticulatum* (Zenker), *emarginatum, senatum et tænioides aliorum.*

(Tab. VIII. figs. 11—13.)

Corpus obovato-elongatum, retrorsum attenuatum, apice caudali interdum emarginatum, ventre nunc panum, nunc concavum, dorso convexiusculum, 70—80 *annuorum et fimbriarum seriebus; caput rotundatum; os ellipticum chitinosum, cujus ad latus utrumque par unum magnorum aculeorum, qui in cute abdominali chitinoso apparatu quodam* (*stylo retrorsum curvato, antrorsum furcatim distante et apice chitinoso cavo, qui mucrones hamuli quieti tegit*) *affixi sunt. Longit. ad* $1\frac{1}{2}'''$, *latit. antrorsum* $\frac{1}{5}'''$, *retrorsum* $\frac{1}{15}'''$. *Habitat in hepate* (*et quidem inprimis in superficie anteriore lobuli sinistri, rarius in lobulo dextro*), *rarius porro in renibus, in mesenterio, in tela submucosa duodeni et in tunica mucosa intestini tenuis, hominum qui Europam mediam incolunt.*

The species here referred to was very exactly described by Zenker, who first found it in the human subject, and every one who knows how to determine the *Linguatulæ* will see that in Zenker's case young *Linguatulæ feroces* are referred to. These *Linguatulæ* are common to man and our herbivorous domestic animals, and if the opinions of Gurlt and myself prove to be correct, they are the immature descendants of the *Linguatula tænioïdes* inhabiting the frontal cavities of the dog, which we regard as synonymous with *Linguatula denticulata, emarginata,* and *serrata,* and only as different grades of development of the same species. They may reach the closed cavities of the bodies of men in exactly the same way as in the Herbivora.

Hitherto Zenker has found the animal only inclosed in a firm, even cartilaginous, fibrous capsule, loosely attached to the peri-

toneal coat and readily detached, which forms a small longish knot, 1—$1\frac{1}{2}'''$ Par. $= 2\frac{1}{4}$—3·37 millim. in length, imbedded horizontally or perpendicularly in the liver, and projecting a little beyond its level. The animal, which measures about 3·2 millim. $= 1{\cdot}417'''$ Par. in length, has usually a lunate curved form in the human subject; it is calcified, and of a yellow colour, and adheres so firmly to the capsule, that the animal can only be freed from it uninjured, with great difficulty, as Van Beneden found in other *Linguatulæ*. The animal is usually found on its side; its convex margin represents the back, its concave one the belly; the head, 0·76 mill. in breadth, as well as the tail, which diminishes towards the extremity to a breadth of 0·15 mill., are both rounded off. Constrictions are exhibited at the margins, probably caused by death. The body is about 0·84 mill. in breadth. The deposition of calcareous matter takes place in the interior of the body after death; by the application of muriatic acid and moderate pressure, the animal becomes transparent, with evolution of carbonic acid.

The skin, which in the uninjured animal brown and opaque, and in separate fragments colourless, limpid, and homogeneous, is beset throughout with series of spines running round the animal (60—80 in all), each of which bears about 160 acute, slender, conical, flexible, glassy spines, directed backwards, and of different lengths in different parts, but on an average about 0·02—3 mill. long. In the free space of about 0·07 mill., between two rows of spines, we see at somewhat wider intervals rows of small, dark rings with double outlines = spiracles = *Stigmata respiratoria* (Diesing), so that two stigmata occur for 3—4 spines.

Of internal organization nothing can be detected from the calcification of the animal. The most important point is the knowledge of the apparatus of hooks, which I first detected in the *Linguatula ferox* of the ruminants, and Zenker afterwards again found upon his preparations, which Van Beneden also can confirm as regards Zenker's preparations.

In the middle of the forehead, and near its anterior margin, there is, in the first place, a yellowish chitinous oval ring, of about the form of uninjured eggs of *Tænia dispar*; at each side of the oral ring lies a pair of yellowish, rather large, strongly curved hooks, recognisable even by the common lens, which resemble the claws of large tapeworms, such as *Tænia crassicollis*, if imagined without stems, and the bases of which are broad,

obtuse angled and emarginate. From this point they narrow rapidly towards the apex. They exhibit double contours, are hollow internally, and lie for the most part in an inversion of the ventral skin. Each of these hooks is borne by a peculiar chitinous apparatus of support. The latter consists of a sort of furrow or fork, the stem of which is bent in the form of a hook, becomes constantly more diminished and curved posteriorly and towards the free apex, but widens anteriorly. This broader portion divides into two sections uniting at an acute angle. The portion turned from the ventral side and directed outwards, divides into two broad, forked lamellæ, which receive the base of the true claw between them, and allow it to swing. The massive portion of the stem directed upwards and inwards ceases at this point at the same level with the lamellæ of the fork, and becomes converted, as it appears to me, into a very thin filament, which, as it were, furnishes the skeleton or point of support for two lateral lobes, which are nothing but two lobes of the ventral skin. These lobes are produced by the impression which the convexity of the hook-apparatus forms from the ventral skin towards the dorsal and into the ventral skin. They are only the mechanical consequences of this impression, and assist in forming the anterior part of those peculiar structures, which the authors describe as cleft-like openings, and which have led to their being confounded with a mouth. Whether this delicate chitinous thread or ridge is really there, or, as Zenker, for example, thinks is not present, others may decide; it is not indispensably necessary, for the convexity of the hook itself might certainly hold the skin upright and stiffen it in the median line of the lobes. Quite in front, and at the point where the sides of the lobes of skin again unite with the flat tissue of the ventral skin, there is a small chitinous structure, which, so to speak, looks like a three-cornered hat *in minimo*. This little body has a cavity which is directed downwards and outwards, and a closed convexity or cover which is turned towards the ventral membrane. In front there is a little beak, exactly like the anterior handle of a three-cornered hat. This little beak usually stands straight out and downwards; by force and strong pressure it may acquire all sorts of different forms, and, for example, bend into a hook. I have formerly given this last-mentioned structure the name of the "*Navicula*;" J. Müller, when I explained to him the mechanism of the movements of the hooks of *Linguatula*, gave it the very characteristic name of the "point-cover" (*Spitzendecker*).

This very point-cover has its own history, so many erroneous interpretations has it received. It has usually been regarded as a hook, which may easily happen, when the point is bent back and the mechanism of its movement is unknown. Hence all authors had hitherto described the point-covers as "the small hooks of the *Pentastoma*." According as the authors saw all the four point-covers, or only some of them, they speak of two, three, or four small hooks. The mistake is explained as soon as one sees a living animal. The hooks swing with their base in the fork, and when in movement, press back the lobes of skin with the hindermost point on the lower extremity of the true convexity of the hook. At the same time the point of the hook escapes downwards from the cavity of the point-cover. If the hook returns again to a state of repose, the lobes of the ventral skin again apply themselves more closely to the whole hinder surface of the hook, the point glides back into the cavity of the little point-cover, and is completely covered by it. With this mechanism the chitinous thread or ridge in the middle between the lobes of skin would be very well adapted to facilitate the play of the hooks, by stiffening the lobes, and, as it were, forming a firm channel for them.

The measurements of the hooks are as follows, according to Zenker:

Distance between the point of the hook (*a*) and the foremost point of the base (*b*) swinging in the fork, 0·042‴ = 0·095 mill.

Distance between the hook-point (*a*) and the hinder extremity of the emarginate basal portion of the hook (*c*) 0·083‴=0·188 mill.

Distance from *b*—*c* = 0·055‴ = 0·124 mill.

Distance between the point *b*, and the hinder convex extremity of the hook, in a straight line, 0·059‴ = 0·133 mill.

This parasite is not very rare amongst us, as Zenker found it thirty times in two hundred dissections.

Second Family—Simonida (Vogt).

Corpus vermiculare, ætate proficiscente diminutum; cephalothorace latiore et molli; pedes breves truncique, mediano aculeo majore armati, in statu immaturiore pedibus 6, *in maturiore* 8; *organa manducatoria rostellum parvulum medianum, duabus laminis gladiformibus acutis armatum, palpisque* 2 *brevibus, duos articulos exhibentibus conicisque instructum præbentia.*

Acarus folliculorum (Simon, V. Siebold). Pimple mite.

(Tab. VIII. figs. 14—16.)

Synonyma: *Demodex folliculorum,* Owen; *Macrogaster platypus,* Miescher; *Simonea folliculorum,* Gervais; *Entozoon,* afterwards *Steazoon folliculorum,* Wilson; Comedonenmilbe.

According to Von Siebold the name of *Acarus* is to be retained for it in preference, as there are also long-tailed *Acari,* for example, that discovered by Dugès in small, pouch-like galls of the leaves of the lime.

Signa generis. Longit. $\frac{1}{10}'''$. *Organis generationis omnino ignotis; evolutione imperfectissime cognita. Species vivipara* (Wedl). ? *Habitat: in capillorum folliculis glandulisque sebaceis humanis et sanis et ægre intumidis, imprimis in tota pilis majoribus carente facie, præterea etiam in reliquis corporis regionibus, ex. c., in pectore, dorso, &c.*

According to Schönlein there is a notice of a mite living in pimples as early as 1682 ('Act. Erudit.,' p. 317); but according to Schönlein and Remak, the figure given by Bonanni agrees better with the so-called Erdl's mite, or more correctly the bird-mite, which will be hereafter referred to. The true pimple-mite was found by Henle and Gustav Simon in 1842, almost simultaneously and independently of each other. Henle found them in the hair-follicles of the external ear, but took the tail for the head, and the feet for sucking discs composed of pads. Simon found them in the pustules of acne, and described them correctly.

With a very variable form the mite is 0·085—0·125''' in length, and 0·020''' in breadth. On the head there are two lateral two-jointed palpi, a tubular proboscis, and a triangular biting organ composed of two fine acute bristles or saws. The head and thorax pass immediately into each other (*cephalothorax*). The short, conical, three-jointed feet are articulated to a chitinous longitudinal ridge of the belly by a chitinous stalk, and are, as it were, borne by this stalk, which runs towards the anterior side of the foot, and thence sends a chitinous branch backwards and round the base of the foot. That these horizontal stalks run round the whole anterior part of the body, as Simon thinks, I have never observed, but I think they belong to the base of the foot. The terminal joint of the anterior feet, according to Miescher, has four, that of the hinder feet five processes. Simon describes each

terminal joint as bearing three claws at its extremity; a long one and two shorter. Wedl could not quite make out these extremities. If we make use of the assistance of varying illumination of the preparation, we see, as I think, only a single hooked claw, of a very delicate kind, projecting from the centre of the foot. On the sides of the anterior free margin of the foot we see a pair of straight, acute processes, which are certainly not horny claws, but only membranous projections of the extremity of the foot, which probably even change their form in different movements. With transmitted light the larger claw may be traced distinctly as a lighter streak, a certain distance up into the substance of the last joint of the foot, whilst the two apparent lateral spines retain the colour of the mass of the foot itself. The free-standing central claw apparently may be erected and somewhat curled. Thus if we employ coloured oils (for example, Macassar oil) in the examination, all the oil is sometimes displaced at this spot during the movement of the foot, and a small round surface is produced, which appears to adhere to the extremity of the foot like a little sucking pit—an illusion which has already frequently occurred.

We meet with the animal in several forms.

First form.—The abdomen is about three times as long as the anterior part of the body; the tail notched like a file. The contents are finely granular, brown or blackish by transmitted light; we also see transparent, irregular, round, oval or quadrangular spots (fat-drops or epithelium). Some observers say they have distinguished an œsophagus, intestine, and liver. This form must certainly be one more approaching to maturity.

Second form.—The abdomen is considerably abreviated, until at last it is scarcely larger than the cephalothorax, and when regarded by itself forms a conical body, pointed towards the caudal extremity, on which the rudiments of segments or transverse rings may be distinguished. This form has always eight legs. There is no doubt that it is the nearest to maturity. But whether the appendage in question at last falls away entirely or not, is at present still a matter of dispute. For my own part, it appears to me improbable that it should be altogether thrown off. Moreover, in one case, I found this form particularly plentiful, whilst Simon mentions the first form as the most abundant; circumstances which probably vary according to the season, the duration of the disorder, &c.

Third form.—It has only three pairs of feet, is narrower than the other forms, the transverse rings in the abdomen are wanting, and the contents are paler, and less in quantity; in other respects it resembles the first form. This younger grade is certainly converted into a higher form by a change of skin.

With these forms there also occurs in the follicles of the skin a cordate body, which Simon regards as an empty egg-shell, and Wedl as a very young animal. The latter appears to suppose that this very young animal occurs already in the anterior part of the belly of the mother, and that he was able to observe the development of the six-legged form from this structure, its middle and hinder part diminishing in breadth, and becoming elongated, when oval organs and pad-like elevations (feet) grew forth. Gruby states that he has found the same species of this family of *Acari* upon the dog, after an experiment on the transference of the human *Acarus* to that animal, and at the same time observed, that in the course of two years these mites had increased so enormously that they occupied every cutaneous follicle, and the dog became in consequence quite naked; statements which have been already doubted justly by Simon and Wedl. Oschatz found a similar *Acarus* in the glands of the eyelids of a sheep. It was, however, broader generally, and especially in front.

Symptomatology.—Even Simon admits the possibility that this animal, innocent as it is in general, may, by excessive increase, become the cause of morbid beauty-spots (pimples and acne pustules). Very recently Remak has narrated the case of a healthy tradesman, twenty-six years old, who travelled a great deal, and had suffered for three years disfiguring acne on the chin, nose, and forehead, as well as on the back. On account of a sore on the *glans penis*, which was observed about a year after this eruption, but soon disappeared without leaving a scar, the patient had subsequently been dosed with mercury, Zittmann's decoction, cod-liver oil, and many other things, without these remedies or the prescribed water-cure having any influence upon the disorder. At length, after long seeking, Remak found the mite, but with great difficulty, namely, by entirely removing the pustules, and dragging the Simonian mite from their bottom, sometimes from a depth of nearly a line. From this case it appears that in particular cases the mite may become the true cause of pathological conditions.

Diagnosis.—In living persons, especially if fat, as well as in

dead bodies, the contents of one or several vesicles may be pressed out by placing the nails upon the skin about 2—3 lines apart, and then moving them towards each other. By this manœuvre the contents of the glands often issue in long rolls. Others use hard instruments for this purpose, such as the handles of lancets; Simon employed a hair pin, or a thin bent sound.[1] With this pressure is to be applied in the neighbourhood of the vesicle. I prefer the former process, because the person to be examined may perfectly well apply the pressure with his own nails, and the surgeon keeps his hands free for the collection of the masses pressed out. We usually find an *Acarus* when we spread these masses upon a glass, facilitate their diffusion by a gentle pressure, and add a drop of (red) Macassar oil. Frequently, however, the result is negative, especially with enormously developed vesicles, and I have sometimes only attained my object by again pressing the spot which has been pressed once already. In the sebaceous matter which then issued, and which was collected with a knife, I found the animals very easily. In dead subjects I have also evacuated them by pressure, but here the animal often retires very deep, and nearly to the origin of the follicle. In such cases we can frequently only obtain the animal by cutting through the skin. In the nose and other parts which cover open cavities in corpses, we may, in case of need, introduce a broad, firm instrument, such as a spatula, into the cavity, and press a glass plate against it from without, so as to collect the sebaceous matter at once upon the glass. The collection of the animals is most easily effected in fat people. But this probably varies according to the general faculty of the skin, to give up the contents of the cutaneous follicles with greater or less ease on pressure. If there is difficulty, the outer covering of the pustules may be first of all pricked, or removed by the knife. We shall then find that the animals occur in extreme abundance, and that authors like Wilson, according to whom but few men are free from the mites, are in the right.

Mode of life of the mites.—They occur sometimes singly, sometimes several, sometimes many (13) together in one hair-follicle. In hair-follicles into which small sebaceous glands open, the animals lie close to the hair; in the large composite sebaceous glands, into which small hair-follicles open, they take up their

[1] Hebra makes use of a rather wide watch-key, the opening of which he places on the most prominent spot and then presses.

position in the efferent duct of the gland, commonly nearer to the outlet of the duct than at the bottom, except when found in corpses. The abdomen is usually directed towards the orifice and the head towards the bottom of the gland; rarely the reverse. They continue to live for a considerable time in fatty oils, whether they are taken from living or dead subjects. If the animals be still, this is only a sort of apparent death, and they again become lively by the application of a gentle heat. Even the warmth diffused by a study lamp excites them to give renewed signs of life. This is also probably the reason why it is so difficult to make permanent preparations of them. For in oily media they at last creep entirely away under the varnish, &c. In general their motions are sluggish.

Therapeutics.—According to Remak, the eruption improved by a mixture of equal parts of spirits of camphor and oil of turpentine; but young mites were still found in four weeks, and in three years the disease was as bad as ever. A popular remedy, a very dear one certainly, is essential oil of cinnamon. The most rational thing would be to apply Durand's gall-stone mixture (*Ol. Terebinthinæ* and *Æth. Sulfur.*) externally, after the sebaceous matter has been squeezed out.

Family of the true Itch-mites. Acarida.

Animalia, mimina, cæca, mollia, non colorata, globiformia, aut in cute animalium cuniculos agentes, et uti videtur venenata, quorum morsu pustulosum exanthema efflorescit, aut in materiis vegetabilibus aut animalibus putrescentibus viventia. Pedibus 8, *in juventute* 6, *brevibus, difformibus, crassius articulatis, a chitinosa machina, ad abdomen affixa, portatis et a linea mediana extrinsecus distantibus, qui in articulo libero et extremo aut unguiculis aut aroliis in stylo quodam affixis aut capillis mobilibus armati sunt; rostello longo, crasso, conico; maxillis crassis, ex forficum forma; palpis parvis cum rostello coalitis. Species plerumque oviparæ. Mares minores et tenuiores; pedibus posterioribus usque aroliis armati. Feminæ majores et crassiores, pedibus posterioribus interdum carentes.*

1. *Acarus Scabiei.* The Itch-mite. (Tab. IX, figs. 1—6.

Synon. *Sarcoptes Hominis seu Scabiei; Cheyletes Scabiei.*
Animalia cuniculos in cute humana agentia, setosa et spi-

nosa; corpore in una massa rotunda coalito; pedibus crassis, brevibus, quorum anteriores in utroque genere arolia, quorum par tertium in utroque genere longam setam, quorum par quartum in maribus arolia, in feminis setas gerit; dorso limarum dentibus, in plures ordines redactis, armato; organis manducatoriis generis. Animalia vernationem ante maturitatem ter exuentia. Mares omnino tenuiores, minus asperi, machinâ pedum chitinosa in pedibus posterioribus inter se juncta; feminæ majores, asperiores, machina pedum posteriorum inter se juncta. Species ovipara.*

There is no doubt that the itch was known to, and much dreaded by, the ancient Greeks and Romans. We might certainly think that Aristotle in the fifth book of his *Historia Animalium*, cap. 31, knew the mites by the eruption of pustules, as he there says, "the lice (φθεῖρες) are produced from the flesh; when the lice have remained longer upon the skin (ὅταν μέλλωσιν, but not, as the Leyden edition translates it, *quibus futuris*) small pustules, as it were, sprout forth, from which, when pricked, the lice issue." But as, even with great uncleanliness, lice do not form pustules, or bury themselves beneath the skin, I refer this observation rather to those cases of so-called phthiriasis, which, as we shall hereafter mention, Fuchs has indicated as produced by mites, unless, perhaps, we are to suppose, from the following passage in Avenzoar, who also still calls the mites lice, that with Aristotle, as with Avenzoar, itch-mites were understood by the lice being under the skin. Avenzoar in the twelth century appears first with certainty to have recognised the mites (*Soab*) as the cause of the itch. "Syrones," says he "sunt pedicilli subter manuum crurumque et pedum cutem serpentes, et pustulas ibidem excitantes, aqua plenas, tam parva animalcula, ut vix visu perspicaci discerni queant." Although, in accordance with the defective entomological knowledge of his period, he may have regarded the animals in question as a species of louse, he certainly meant thereby quite a different animal from the headlouse, and recognised the mite as the cause. Through the whole of the middle ages the knowledge of this mite was now maintained. Scaliger writes in his epistle against Cardanus in 1557: "De Acaro senibus Aristotelico recto eum cum Garapate comparasti. At quare longo minoris animalis oblitus es? Pedicellum Piceni, Scirum Taurini, Brigantem Vascones vocant. Nempe admirabile est. Et forma nulla expressa, præterquam globi. Vix oculis capitur magnitudo. Tam pussillum est, ut

non atomis constare, sed ipsum esse una ex Epicuri atomis videatur. Ita sub cute habitat, ut actis cuniculis urat. Extractus acu, super ungue positus, ita demum sese movet, si solis calore adjuvetur. Altero ungue pressus haud sine sono crepat, aqueumque virus reddit." Joubert, who probably only reproduces Scaliger, in 1580 refers to the itch-mite as a small species of louse (*Syro*), which, like the mole under the earth, produces passages under the skin, and thus causes a troublesome itching. Aldrovandi (lib. v, 'De Insectis,' cap. iv, p. 215, article Genus differentiæ) in 1623, also gives a sort of paraphrase of Scaliger; he thinks the mites are destitute of feet (which, according to him, had been incorrectly said by Mercurialis of the crab-louse, but which might have been said with greater justice of the itch-mite), describes them as concealed beneath the skin, and explains the popular name Pellicelli, "quod inter pelliculam et cutem serpant" (as he afterwards adds, "clam erodendo, et molestissimum excitando pruritum), sinuantes sibi velut cuniculos, seu vesiculas non suppurantes, quas si quis perforet, exeunt albi, adeo tamen parvi ut vix deprehendi oculis possint; non tamen fugiunt acriorem visum in loco maxime lucido." He also states that the extracted animals, when crushed between the nails, burst with a noise. He then continues: "Minimi, quos Cyrones et Pedicellos nominari diximus, manuum ac pedum digitos potissimum inficiunt, inter cutem et cuticulam, ova Papilionum quodammodo sua figura æmulantur: sunt enim rotundi, exigui, subcandidi." I have reproduced this passage exactly, because the Englishman Moufet (1634) is usually cited as being the best acquainted with this mite of any one in the middle ages, of whom, however, I must assume that he was much less acquainted with this animal than the *Pontifex maximus* of natural history at the commencement of the 17th century, Aldrovandi, and moreover, that he was the first to introduce the unfortunate confusion with the cheese-mite. Martiny quotes the passage from Moufet's 'Insectorum Theatrum,' Londini, 1634, p. 266, as follows: "Syro (apud Germauos 'Seuren') animalculum est omnium minutissimum, solens innasci caseo et ceræ et cuti item humanæ. Syronibus nulla forma expressa præter quam globuli vix oculis capitur; magnitudo tam pusilla, ut non atomis constare ipsum, sed unum ex atomis Epicureis dixeris . . . Ita sub cute habitat et actis cuniculis pruritum maximum loco ingenerat, præcipue manibus vel aliis partibus. Hos peculiariter vulgus acicula extrahit; sed cum non simul tollatur causa, eorum

fomes, perseverat affectio. Itaque præstat unguento vel fotu eos occidere, quo simul tollatur pruritus ille infestissimus."

It is not easy for an author to arrive at such unmerited honour as Moufet, who has copied what is good in this description, and added what is bad; for example, even the statement that the cause of disease cannot be removed with the needle.[1]—After these authors, as Martiny states, we have to mention particularly as writers upon the *Sarcoptes*—Hauptmann, of Dresden ('Uralter Wolkensteinischer warmer Bade und Wasserchatz,' Leipzig, 1657, and a letter to P. Kircher, who thought he had seen the animals in the plague-boils, and figured them with six feet and four hooks); Hafenreffer ('Nosodochium, cutis affectus,' Ulm, 1660); and Redi, who in 1683 described and figured the mites very well after a letter of Bonomo's, which was afterwards claimed by Lanzoni for himself ('Osservazioni intorno a pellicelli del corpo umano, dal G. C. Bonomo, Fiorenze'), and was inserted in the 'Miscellanea naturæ curiosorum,' translated into Latin in 1691, but subsequently confounded with a letter of Cestoni to Vallisneri in 1710, and arranged in the 'Collection Academique.' The itch-mite is also referred to in the 'Acta Eruditorum,' 1682, and the 'Philosophical Transactions' for 1703. Linné, whose scholar, Nyander, describes the actions of the mite very well in his dissertation, 'Exanthemata viva, Upsal, 1757, according to the opinion of most people never saw it, but mistook the

[1] A fundamental confusion prevails here, because one has copied from the other without criticism. In the fifth book of his 'Historia Animalium,' cap. 31, Aristotle treats of the lice of men and animals, even those of the fishes and also of the ticks (*Ixodidæ*), and states that the ass is without either lice or ticks. In the thirty-second chapter he no longer treats of lice, but of the moths, *Acari*, the paper-mite, &c. Aldrovandi, on his part, has fallen into an error, in appending the Aristotelian *Acarus* immediately to the *Scirrones*, the true human itch-mites, merely on account of their smallness. In a remarkable manner Aldrovandi also allows the Aristotelian *Acarus* to be an animal living in wax, probably misled by the edition which he used, and which was probably the Leyden edition of 1590 also used by me. In this, in the text edited by Theodor Gaza, stands *καὶ ἐν κηρῷ γίνεται*, whilst we should read with Sylburg, *ἐν τυρῷ = in caseo*. The Aristotelian *Acarus* is nothing but the common cheese-mite. The case of Aldrovandi, who refrained from giving an opinion upon the *Acarus* in wax, because he found no *Acarus* in wax in Italy, is the case also with us in Germany, and will be the case with everyone everywhere. I have inquired about wax-mites from a well-informed artisan, now seventy years of age, who has been in contact with wax from his youth, but he assures me that he had never seen or heard of such a thing. Then to make the confusion complete, Moufet mixes all together, and describes the mite as living in cheese and wax, but at the same time also in the human skin.

meal-mite for this animal, and regarded it as a variety of the cheese- and meal-mite, as *Acarus humanus subcutaneus et scabiei* Geoffroy and De Geer regarded it as a distinct species; Morgagni, Fabricius (who saw it amongst the Greenlanders,) and Wichmann were very well acquainted with it; but as it is difficult to find, it was for a long time forgotten, until at last the Parisian student Galés, in 1812, was the occasion of attention being again paid to it, by the famous substitution of the cheese-mite for the true mite ('Essai sur le diagnostic de la Galé, sur ses causes et conséquences médicales et pratiques à déduire des vraies notions de cette maladie,' Paris). His figures resemble De Geer's figures of the cheese-mite. In 1834, following the Corsican Renucci, Raspail at last succeeded in finding the true mite and detecting the mistake of Galés, so that the renewed knowledge of the mite dates from Raspail, although he could not prevent Lareille from uniting the itch-mite and the cheese-mite in Cuvier's 'Règne Animal,' or Lamarck and Nitzsch from expressing the opinion that two species of mites might perhaps occur in the itch. Since this time the knowledge of the mite has been gradually advanced, especially by Eichstädt, who was not acquainted with the male, by Hebra and Gudden, also through Krämer, of Gottingen, in 1846, who first distinguished the male from the female, and later above all by Bourguignon, who first gave a good description of the male, which was discovered by Languetin.

In this historical statement I have followed Martiny and my own studies, but departed essentially from Gudden, who ascribes Cestoni's letter to Bonomo, makes it to have been directed to Redi instead of Vallisneri, and altogether sums up the history very superficially in these words: "If we add thereto (Cestoi's letter) from recent times, the works of Eichstädt and Hebra, and perhaps also those of Bourguignon, we have got together the best of the literature upon this subject." In details I shall follow the treatment and arrangement of the subject according to Hebra, Schinzinger, and Gudden, with reference to my own observations.

Habitation of the mites and the mode of finding them.—Even Nyander says in his dissertation: "Acarus sub ipsa pustula minime quærendus est, sed longius recessit; sequendo rugam cuticulæ observatur; in ipsa pustula progeniem deposuit, quam scalpendo offringimus et disseminamus, ita cogente natura." According to Gudden we find the mites and their egg-passages

on almost all parts of the body, and not only on the hands, the male organs of generation, and the nipples of women, if we only search for it carefully everywhere. Nevertheless, the hands present peculiarly favorable conditions for the discovery of the galleries, because these become more strongly marked in consequence of the collection of dirt in their air-holes; and they are also usually more numerous on the hands, and on the organs most frequently touched by them, such as the male generative organs, or the female breasts. Nevertheless, there are cases in which, whilst the trunk is covered with passages, the hands are quite free from them; as is the case, for example, with those who, like painters and lacquerers, soil their hands daily with fats and oils of all kinds. According to Gudden, the hands of such individuals especially remain unattacked, in whom the hands are always cold, as, for instance, in potters, or those who have always wet, cold hands, such as washerwomen. In individuals suffering from habitual cold feet, who can only get warm with difficulty even in bed, the whole body except the feet may be covered with mites. For it is a fact abundantly proved by experience, that the mite becomes more active at all times and in all places when warmed (for instance, in the warm bed, by staying in the sun or at the stove, by dancing, or heating movements or beverages in the winter), but becomes more sluggish in the cold; so that the patient may diminish the troublesome itching immediately and in a short time by leaving his bed in the winter, if he does not sleep in a heated room. For all these reasons the mites do not like the face, which is usually kept bare even in bed, and exposed to the cold; but they nevertheless nestle in it perfectly well in little babies, which are completely packed up in bed. Mites were also found in the face of a man who used to sleep upon his left side and draw the bed-clothes carefully up to his chin; but only in the left cheek which was kept warm.

At the moment of penetration it gives the mites the greatest trouble to pierce through the uppermost horny layer of the epidermis; and this the greater, the thicker, firmer, and coarser the uppermost epidermal layer is. They effect this penetration in a nearly perpendicular direction, placing themselves upon their anterior feet, and supporting the body with their long posterior setæ. For the boring in itself they require from ten to thirty minutes. For these reasons the mites in general prefer the delicate, less firm, and thinner spots of the body; and therefore the space between the fingers, the outside of the hand, the inner surface of the wrist,

the inner surfaces of the limbs, the entrance to the axillæ, the abdomen, the anal cleft, the scrotum, the penis, the nipples, the cavity of hair-follicles, &c. When they have got under the epidermis, the boring goes on more rapidly. The hinder part of the animals sinks, and the mite penetrates in an obliquely pierced passage towards the cutis. The knowledge of this direction is of importance for the discovery of the mites in their galleries.

Various methods have been employed for the detection of the mites. The best is that of Eichstädt and Hebra, which Gudden has only modified in one point. To examine places in the skin on which points, papillæ, vesicles, or passages occur, the skin is raised, if possible, into a fold, and the epidermis, with the superficial layer of the cutis, is removed from it, according to Eichstädt and Hebra, with a pair of scissors, but to suit the surface; and, according to Gudden, with the rapid stroke of a fine sharp knife, which certainly gives some pain, but not so much as the removal with the scissors, and does not leave such a bad wound. Eichstädt rubbed green soap into the spot selected for incision on the previous day, in order to produce a slight inflammation and exudation, which somewhat elevate the gallery and facilitate the excision. The fragment of skin thus removed is carefully spread, with the inner surface upwards, upon a glass plate, and the preparation is allowed to dry slowly, but not to become brittle; it is then turned over, laid in concentrated mastic varnish, and after getting rid, as far as possible, of injurious air-vesicles by gentle pressure, or, when this is of no use, by leaving the preparation for twenty-four hours in the varnish, it is put under the microscope. The outlines of the gallery are certainly thus rendered almost transparent and extremely delicate, but particularly easy to recognise where they contain a mite, or a few balls of excrement. In short, in this way we contrive to observe the entire natural history of the mite at one glance. Still more easy, and in ordinary cases sufficient for the diagnosis, is the method already described by Aldrovandi, Nyander, Bateman, and Wichmann, and again introduced into science by Renucci, who learnt it from the Corsican women. With the naked eye or with the lens (Schinzinger), we examine a large passage, and pierce it carefully from the side at the end, where a whitish point shines through, with a cataract needle, a lancet, or a common needle, remove the covering from the passage, and

thus get below the mite, which is exposed, and lift this out. Many have acquired great expertness in this process.

The males can only be found with the lens. According to Worms they are always in the vicinity of the galleries, and shine, as brown points, through the skin, which only exhibits slight traces of reaction. Here we must choose the removal of such points with the knife.

The young mites are usually found only in fresh vesicles, as they readily emigrate; but mites engaged in the change of skin often occur in the papillæ and vesicles which have already attained a further development. If we wish to search for these little pale creatures, great care is required, and we must have good magnifying glasses attached to the eyes. The object is better attained in this case by the removal of the vesicle, especially if we examine the vesicles starting up after a thorough washing with soap (Eichstädt), or, what is better, with oil of turpentine. The mites remain dead on the spot where they lie, and the reaction subsequently produced shows their position. In vesicles (that is to say, the anterior extremities or heads of the galleries) or in true pustules, we either find no mites at all, or only dead ones.

The course of the disease, from the moment of the immigration of the mite into the skin up to its height, has certainly been best elucidated by Gudden, by his inoculation experiments.

If a female, a male, or a young animal, gets upon the warm, uninfected skin, the little animals, and especially the males, run quickly about, according to Worms, passing over a space of two centimetres in a minute, then stop, turn round, run further, and either bite in immediately, or quit the spot and commence afresh in another place. These manœuvres may be traced with the naked eye or with the lens, when a specimen of one of the abovementioned degrees of development is placed upon the outer lateral surface of the hand, of which the mites are particularly fond, and where they may be easily isolated. If the animals run away from it they are brought back with the needle, or if they will not bite in at all, they are removed altogether. The mites bore, as already stated, perpendicularly into the epidermis, and when they have pierced this layer, they penetrate obliquely into the cutis, never below this, as under the lowest stratum of the epidermis, they find their principal food. If they

arrive by this means a little later at the level of the nervous papillæ, they attack these directly or indirectly, and produce a fine, pricking pain, which is either repeated or remains quiet for a considerable time, and which we denominate *biting*. The deeper the bite goes, the more abundantly does the exudation pour itself out in consequence of the reaction between the cutis and the youngest laminæ of the epidermis; this elevates the mite, and also occurs in its stomach as a colourless paste. In general, the more abundant the nutritive material furnished to the mites, the less do they penetrate, and the less do they plague with biting. The younger the mite is, the younger is the epidermis which it requires for its nourishment, and therefore the young penetrate most deeply, irritate, gnaw, bite, and produce the strongest reaction and exudation. Young mites, however, when they find a sufficiency of nourishment, remain more at the surface; older mites, also, in one and the same gallery, sometimes go deeper, probably when there is a deficiency of nourishment for them, and even have blood in their stomachs. Here and there, in the larger galleries, when laid bare and rendered transparent, there is an extensive exudation; but when the mite remains at the surface, no exudation is produced. Where the epidermis is very thin, as, for example, on the generative organs, the mites pass deeper towards the cutis, in order to bore into it, by which the exudation becomes rich in fibrine and traces of blood. Besides the shooting and evanescent sensations of pain, little is observed at first externally of the mites which have immigrated into the epidermis. They remain in the galleries, advance further in a horizontal direction, or wander out and enter afresh at another place. The most restless are the six-legged young before they change their skins, and the maturer males, which rarely remain in the same place longer than one to three days; and the galleries of which, therefore, are seldom 1‴ in length. Fecundated females bore further in their galleries, just as females after the third change of skin, usually make themselves a long passage.

But whether the mites remain or emigrate, wherever their bite goes deeper, there is always formed an exudation in the course of a short time in the normal skin; and this, usually on the second day, elevates the epidermis with the gallery of the mite into a papilla or vesicle. From the fifth day the vesicle begins to dry up slowly; the epidermis scales drop off, and the itch-process has been

gone through in that place. The mechanical injury done to the skin by the mite, does not, however, appear to be the cause of the eruption of the itch; but, according to Gudden, this is to be found in the circumstance that the mites, like other parasites, emit an irritating fluid with their bite. Gudden supports this view by the fact that we may penetrate beneath the skin with a needle, and rub cinnabar into a canal thus formed and yet produce no itch-like eruption, whilst by dropping in tincture of cantharides on the mass formed of triturated mites, a little pain is produced at first, and in the course of a day or two a slight exudation. More remote proofs of this supposition may also be found, in my opinion, in the phenomena following experiments in inoculation with the matter of smallpox and syphilis.

From Gudden's experiment of the transference of a mature, impregnated female upon the healthy skin of an individual, the following was ascertained as to the time of the process of development. The mite dug its gallery and deposited its eggs. On the ninth and tenth days, the individual experienced distinct gnawing and pricking on particular parts of the hand, readily distinguishable from the imaginary itching hitherto felt over the whole body, of which the person had complained. Vesicles and papillæ now rose immediately, and these gradually diffused themselves in increasing numbers along the arm; from some of the vesicles which were just rising Gudden was able to extract the mite with the needle, and in others, when the mite was already gone, he could detect the gallery. The latter appears rounded off at the end, but sharply bitten out at its entrance, and has, although only when superficially examined, an accidental similarity with hair-follicles destitute of hair, with the convolutions of sudorific canals, or especially with the epidermic hoods of the cutaneous papillæ.

By experiments carried on simultaneously on distant parts of the body, as well as in fresh cases of infection with itch, we may perceive that every egg-gallery becomes the centre of a circle of the disease, from which the young brood diffuses itself in radiating galleries. When the disorder has lasted longer, the separate circles certainly become mixed, and it is then impossible to discover them.

The galleries vary greatly in size, and may be distinguished into the long-known larger ones, which are recognisable by the naked eye, scarcely raised above the level of the skin, and sensible to the finger, and the smaller ones, which are scarcely visible. The larger

galleries are burrowed out by females after the third change of skin, and by fecundated females; the longest (up to $\frac{1}{2}''$ or more in length) are for egg-galleries. The burrows of the young mites are shorter, at the utmost $1'''$ in length, and pass obliquely from the epidermis to the cutis; the shortest galleries (mere holes) are those of the males. The burrow of the galleries corresponds with the breadth of their inhabitants; old galleries become narrower by their walls approaching each other more towards the entrance. The direction of the galleries, which is probably determined by the direction and depth of the furrows of the epidermis, varies; it is sometimes straight, sometimes tortuous, sometimes angular, sometimes bent and looped, so that the gallery intersects itself. The entrance is generally free; in the case of males before copulation, sometimes covered with fragments of epidermis; its margins are sharply bitten out; when the galleries are not too long it serves at the same time as a means of egress. Galleries after the third change of skin have a separate egress. The impregnated females leave their galleries no more; they constantly burrow further onwards and die in its blind extremity. The males also appear to die after copulation in the last gallery which they have excavated. The larger galleries on the hand form blackish punctured lines (which is due to the lodgement of dirt); on the body these lines are whitish. The latter colour is due to dried epidermic scales, but the points are round or cleft-like apertures in the upper wall of the gallery (air-holes and apertures of egress for the brood), which are never wanting in large galleries, and which stand at equal or unequal distances apart. In the galleries we often see cast skins and balls of excrement, longitudinally rounded, slightly tubercular, dark-yellow or dark-brown bodies, of about $\frac{1}{14}'''$ in length, and often caked together (Eichstädt), which vary according to the size of the animal, and represent its excrement.

These would be the primary objective phenomena, which, however, very rarely occur alone, as Baum, Eichstädt, and Gudden have seen, when all reaction and exudation keeps away. According to the variable irritability and reaction of the skin, various secondary objective phenomena associate themselves herewith, or the immigration of the mite combines with other accidental cutaneous diseases of the individual. If certain cutaneous diseases are endemic anywhere, a peculiar external form may, as it were, be impressed there endemically upon the itch. As regards the former, we must refer particularly to the quantity of exudation and the

resistance of the skin. When the quantity of exudation is small, and the resistance of the epidermis strong, we meet with papillæ, and the formation of vesicles is hardly attained; if the contrary be the case, the progress is more rapid, and the papilla then occurs only as a transition state. The quantity of the exudation is determined by the depth of the bite, and by the local reactive power of the organism; the resistance of the epidermis by the delicacy of its uppermost layer, and by the firmness of its adhesion to the *rete Malpighii*, which varies in different places. Thus on the hair-follicles, to which the mites willingly attach their galleries, on the extremities (with the exception of the hands), and on the trunk, we usually find only papillæ, on account of the firm adhesion of the epidermis to the *rete Malpighii;* between the fingers we generally meet with vesicles, but on the penis only with points with a fibrinous layer of exudation, the epidermis indeed being very delicate, but the *rete Malpighii* very imperfectly developed. By gradually increasing pressure we may press the exudation up in the skin, and convert papillæ into pustules. These are therefore no internal differences in the disease, but only accidental ones; the only characteristic mark is the gallery of the mite.

Frequently the exudation after each bite is tolerably abundant, fluid, and purulent, forming large pustules; at other times it is in small quantity, more consistent, and causes the cutis to swell more, so that the place where the mite sits is surrounded by a wall-like circle of injection, although no vesicle is perceptible. The latter, as is well known, has led to the admission of a *Prurigo sine papulis*. From all this it appears that the eruption and number of mites generally stand in a certain relation one to another, and that, in the examination of individual cases, we must not leave unnoticed the difference in the reaction of the cutis. Particular mention is due here to the so-called Norwegian itch (in the distinct Bergenstift). Its cause, according to Hebra, is not, as he at first supposed, to be found in a peculiar *Acarus*, but in the ordinary *Acarus Scabiei*. According to Boeck, who first treated of this itch, and Hebra, the peculiarity of this form consists in the formation, according to circumstances, upon larger or smaller spaces of the body, of several yellowish, dingy-white, scaly scabs, from a line to an inch in thickness, or of callous masses, even with a greenish tinge (epidermal swellings), which sometimes coalesce, and sometimes not. Such wheals even extend to the face. When the nails participate in the process, they appear un-

even, rise up, and become inflated. No one would have supposed that we had to do here with the common itch, if the mites had not been found in it. With regard to the progress of the disease, Boeck states, that the disorder commences with the formation of red spots upon the hands and feet; the epidermis then becomes covered with scales, and afterwards with thick crusts, first on the extremities, then on the buttocks, on the face, the hairy scalp and the neck, and at the same time the nails begin to degenerate. The crusts can be removed by baths, when the skin appears red beneath them and is quickly regenerated. Lastly, there is found upon the palms of the hands and soles of the feet, on the flexures of the thighs and legs, on the buttocks and elbows, on the hairy scalp and the neck, firmly adhering crusts of 2—3‴ in thickness, of a dingy grayish-green colour, and as hard as bark, rendering the extension of the fingers impossible, and the skin beneath them inflamed and moist. The nails formed are an uneven, cartilaginous, yellowish-brown mass; the hairs fall out upon the detachment of the crusts, and bald places remain. The rest of the skin is inflamed, and exhibits brownish-red round spots on the lower extremities, and separate vesicles on the forearms.

Under the microscope, mites, mites' eggs, and excrement, imbedded in epidermic layers, were met with on all the affected parts, but no galleries were found, and the eggs were therefore found without order in the mounds of epidermis and in the callous thickenings—crusts of the epidermis—inhabited by the mites instead of galleries. All the patients in the same ward, as well as the nurse, were infected with ordinary pustular itch, although here also no galleries were to be found. Subsequent investigations made the last result doubtful, and above all, the observations upon the Continent have diffused light over this disease.

In his first report ('Wiener Med. Wochenschrift,' xlviii, 1852), Hebra thought that the great uncleanliness, the phlegm, and the indifference to diseases displayed by the Norwegians, were the causes of this form, by allowing the mites to accumulate in masses upon the body, constantly seeking new and more convenient places, and hence even reaching the face. But, according to him, even the migration to spots which mites do not usually attack, would not suffice, if room were not given, by the accumulation of epidermis, for the mites and their eggs, in the formation of the wheals, which only consist of an agglutination of these three structures with plastic, hardened lymph. In the January number

of the same journal, for the year 1853, Hebra also reports that in one of the most intense cases of the disease, Boeck only met with single living mites. This appears to me to show that the production of this form of the disease is determined, not alone by the number of the mites, but by a certain disposition of the skin, caused by bad management, or by endemic influences and climate, or communicated by diseases (local or general), and which consists in the separation of the plastic lymph in large masses. If the management of the skin in certain districts be particularly bad, and a tendency to plastic cutaneous diseases be also indigenous there (we may refer to the *Radesyge* in Norway,) the disease may probably become endemic, whilst in other districts it only occurs isolated in particular cases. Fuchs is probably of the same opinion, when he recommends that those individuals who suffer from psoriasis or from squamose cutaneous eruptions, should be infected with itch-mites, a recommendation which is certainly worthy of consideration for the elucidation of this subject. For the views just expressed, notwithstanding the shortness of our acquaintance with the existence of this disease, we already find, *in praxi*, various vouchers from the most different countries. Thus, in one case, Fuchs saw pustular itch and the ordinary itch-mites and their galleries upon the whole body, whilst on the elbows and knees he found large scaly crusts (epidermic laminæ laid over one another, with immense numbers of mites, with their excrements and eggs), which Hebra and Boeck declared to be identical with the crusts common in Norway. In a second case, which had existed for fourteen years, the pustular itch appeared all over the body, but on the upper-arm, the upper part of the body, and especially on the elbows and knees, nay, in the face, there were crusts of the size of four- to eight-groschen pieces. Rigler, of Constantinople, saw these crusts all over the body of a Jew boy, with the exception of the upper-arm, the axillæ, the hairy scalp, and the back of the chest. Hebra himself saw these crusts developed in the palms of the hands of a syphilitic patient, whilst on the rest of the body all forms of itch occurred. Büchner, of Tubingen, lastly, describes a case which I reproduce here, from No. 4 of the 'Deutsche Klinik,' for 1855, as being peculiarly instructive with regard to this form. The skin of the whole trunk, especially on the right side, was of a dark-red colour in spots, covered on the back with ragged epidermis in the act of being thrown off; it was also thickened on most parts of the trunk, uneven, and in places

forming hard knots. The entire right arm, especially the fore-arm and hand, appeared enlarged and thickened about one half, as in elephantiasis, unyielding, covered with knot-like elevations, and on the back of the arm with bran-like scales. Immobility and thickening of all the fingers, want of strength, weight, insensibility, and uselessness of the right arm, with violent pain in it, followed. The entire inflamed cutaneous surface of the trunk and arm secreted a pale greenish, tenacious fluid, which left stiffened spots in the linen. The skin of the scrotum, also, as well as that of the lower extremities, presented the commencement of degeneration, although only in a moderate degree. The patient experienced a troublesome biting and itching over the whole body, especially at night; from this the insensible right arm only remained free. In a few days, galleries and *Acari* were found. The introduction of treatment for the itch removed the itching, the moisture, and the eruption. The limbs acquired a normal epidermis, diminished in bulk and increased in mobility, so that a complete cure may be hoped for.

After this digression we return to the description of the disease in its ordinary course, and have still to speak of the subjective phenomena, consisting in the sensation of biting and itching, which lead to scratching, which again, as a fresh irritation, increases the objective symptoms, renders the exudation more abundant, distends the papillæ and vesicles, removes larger galleries from their positions, or, when the inflammation penetrates more deeply into the cutis, produces red spaces round the pustules, and even patches of inflammation under the galleries. In a still higher degree, scratching leads to loss of blood, in consequence of the bursting of blood-vessels which are at the bottom of the exudation, to the desiccation of the latter into small, reddish-brown, hard crusts, or small sores covered with scabs; but very reckless scratching produces furunculi and larger ulcers, which are seen particularly upon those places which the hands can easily reach (Hebra), whilst in cripples, who cannot scratch themselves, and individuals who are confined in a strait-jacket, or those who can command themselves sufficiently not to scratch, they are wanting.

Description of the Itch-mites.

1. *The adult female mite* is visible with the naked eye, and forms a roundish, dimly-shining, grayish-white corpuscle, $\frac{1}{5}$—$\frac{1}{4}'''$

in length, and $\frac{1}{7}$—$\frac{1}{6}'''$ in breadth, with hairs and bristles; under the microscope, a truncated, tortoise-like oval, notched before and behind, flat on the belly and convex on the back. The skin breaks with difficulty, and exhibits irregular segments, with margins lying over one another posteriorly, which form a system of parallel lines. On the back we see small, transparent cones, or, more correctly, teeth, in several rows, which I have indicated in the mite of the cat as file-teeth for boring the galleries, and also near these some long, thin hairs, and on each side ten peculiar, truncated, hollow processes, which are moveable, according to Eichstädt, and of which the three anterior are shorter and thicker; the seven posterior, arranged in two rows, are longer, and, according to Gudden, open at their extremity, but form little rings at their base, in the cavity of which they are inserted with a short stalk. It appears to me to be an optical illusion to suppose them to be open. What purpose they serve, I do not know; but they may, perhaps, be employed as organs of touch.

The feet are supported by a yellow, chitinous framework, attached to the belly. For the first pair of feet of the female there is a single massive bearer (band or stalk), the common simple stem of which runs in a straight line almost from the middle of the animal towards the head. At a short distance from the head this stem divides into a fork, and then forms a sort of triangular framework for each separate basal joint of the first pair of anterior feet. On each side of this straight stem, and nearly in the same level with its hinder extremity, there originate two massive bands (stems or bearers), convex towards the median line of the animal, and concave externally, which bear the same triangular framework at their anterior extremity, for the basal joint of the foot of the second pair.

The two hinder pairs of feet are also supported by a particular horny framework. The third pair of feet is attached by a more bowed stem, concave internally, convex outwardly, and furnished on the outside with a small tubercular spine; from this the triangular framework of the basal joint of these feet originates. The last (fourth) pair of feet exhibits a short and straighter stem, which runs obliquely from within outwards. It is characteristic of the mature female that there is no transverse band between the posterior pairs of feet. It would deprive the eggs of the space necessary for their evolution, and render the extension of the belly difficult or impossible. Each of the four anterior feet

consists of four more or less distinct joints, on the foremost of which there is a hollow, moveable staff, permeated by a sinew, with a sucking cup also perforated in the centre, which is extended flat at the moment of adhesion, and collapses longitudinally, when the animal lets go its hold. At the same time there are some hairs upon the foot which become strong bristles quite anteriorly at the origin of the staff, on the inside of which a sort of short, sharp claw shows itself. The hinder feet are shorter and weaker, and at the same time less clothed with hairs on the side. Instead of the staves with their sucking discs, they have a long bristle, the third pair a longer one than the fourth, and on the inside of this bristle a much smaller bristle or claw. At the base of all the feet there is a powerful, readily recognisable, transversely striated muscular structure.

The head, which is to a certain extent retractile, consists of two *valvular upper-lips*, which are firmly coalescent with the *slightly toothed jaws*; of two jointed *maxillæ*, which are arranged in the manner of a grating, and saw in a horizontal direction upwards and downwards; and of the more massive, immoveable *lower-lips*, which are coalescent beneath, and stand out from each other in the form of a channel above. It has eight fine, inarticulate filaments or hairs (four lateral and four directed forwards), and on each side a vesicular, globular dilatation, which, according to Gudden, probably produces an acrid secretion, which causes the formation of eruptions. The eyes are wanting. After the head follows the œsophagus, with the muscles of the jaws originating from it, and after this a lobate stomach, which is seen most distinctly when it is full of blood, or when the animal is made to swallow oil (for which I regard coloured oils, as, for instance, Macassar oil, as the best adapted), and from the lowest angle of which originates the extremely delicate and slightly curved intestine, which can only be traced in parts when in the full state. The latter opens into the anus, that is, into a longitudinal cleft at the posterior margin of the animal, between the larger orifices of the vagina, through which mature eggs may be passed out by a gentle pressure. Tracheæ are wanting. If the mite be laid upon its back and covered with a thin glass, we may, according to Gudden, simultaneously with a movement of the jaws, see air enter in small vesicles into a narrow air-sac, which extends below the œsophagus and stomach, beyond the middle of the ventral surface. But whether this is actually the way in

which the mites breathe is very doubtful, as most of the Arachnida respire through an aperture in the anterior part of the belly. In point of fact, a small, round aperture, surrounded by a horny ring, does exist in the middle of the anterior part of the belly, just behind the end of the stem which supports the first pair of feet. That this may serve as the opening of the respiratory sac is very probable. This supposition acquires still further confirmation from the circumstance that when mites are forcibly pressed, a small air-vesicle collects at this spot, and therefore on the ventral surface of the mite, which can only be got rid of with difficulty. The nervous and circulatory systems are wanting. The animal contains numerous fat-drops. The ovary exhibits one large egg, ripe for laying, of $\frac{1}{15}'''$ in length and $\frac{1}{25}'''$ in breadth, and also several oval eggs of various sizes, of which one female lays more than fifty. They strongly refract the light, lie with their longitudinal diameter in the transverse diameter of the gallery, on the hands in rows of 2—6, on the body in uninterrupted rows of as many as twenty-one close together. The greater number of the eggs in a gallery of this kind are already burst and collapsed at one end. Fresh eggs have amorphous contents, and pass through an ordinary process of segmentation and development up to fully developed young moving in the interior of the shell. In making their escape they extend the bristles, which are at first crossed upon the belly, against the bottom of the shell and burst it.

The young mite either quits the parent gallery through one of the air holes soon after its exclusion, or eats its way deeper into the bottom of the passage, producing phenomena of reaction, or digs a lateral gallery for itself to the outside, and then burrows in again at a greater or less distance. The mite is now about $\frac{1}{14}'''$ in length, and hexapod.

The male, which is extremely small, lives in small galleries, or, more correctly, in small holes, and appears to die soon after copulation. It is about half the length of the female. The anterior feet resemble those of the female, except that they approach more nearly to the hinder feet than in the latter. The horny frameworks and supports of the individual hinder feet are certainly similar in structure in the two sexes, but in the male they are not free as in the female, but inserted into a slightly sigmoid transverse band, running across the body of the mite, from the central point of which issues an apparatus also of a

chitinous nature, which has the appearance of the vertical section of a bell, and is destined to support the powerful penis which is obtusely rounded at its apex, but perforated through the middle. The third pair of feet is otherwise exactly similar to that of the female, but the fourth pair resembles the anterior feet in being furnished with a stalked sucking-cup. In other respects the males exactly resemble the females.

Bourguignon describes the male sexual organs as follows:

On the surface of the abdomen, between the epimera of the hinder legs (*i. e.*, between the comb-like processes which pass from the coxa of the hinder legs in a bent form forwards and outwards), there are the four following sections of structures, which are wanting in the female: 1. A portion placed between the epimera of the last pair of feet, broader at its anterior extremity, narrower behind, then again broader, and soon dividing into two branches running backwards. 2. A portion enclosed in front by branches of the first portion, which has a glandular body at its central point, and thence also divides into two branches, which are at first parallel with those of 1, but afterwards intersect them externally. 3. A portion enclosed by 2, also divided into two branches running backwards, and with a glandular body upon its median line. 4. A portion usually originating in the abdomen, upon and below the plane of this apparatus, and only visible after the destruction of the mite, namely, a filiform structure, uncoiling posteriorly, the *penis*, which protrudes from its sheath at a little distance from the orifice of the rectum. (See also Krämer, 'Illustrirte Med. Zeitung,' iii, No. 10.)

The male has also a sucking-cup on the fourth pair of feet instead of a hair, and the epimera of his hinder feet are united by a transverse band. Bourguignon here states that the third and fourth hinder feet of each side are only united by a band, but that the transverse band is wanting, in which he is wrong. In the male, also, the horny appendages of various sizes and thicknesses on the dorsal shield are wanting, which, according to Bourguignon, prevent retrogression and facilitate progression. The male is never whitish, shining, thick, and globular, but blackish, flattened, with a retreating angle at the level of the hind legs; and, lastly, much stronger and more active than the female. The hexapod form exhibits no sexual distinction. The male digs his cave in 10—15 minutes without any pain to his host. Bourguignon

is in the wrong when he says that it never makes itself a gallery. According to Bourguignon, the greater activity of the male is effected by the suckers upon the fourth pair of feet, which I cannot agree to, any more than the statement that the male quits his dwelling every twenty-four hours, and goes upon the quest at night like all wandering mites. This takes place under the influence of warmth (*vide infra*) whether by day or night, as is also confirmed by Hebra.

Before becoming mature males and females, the young mites, like all Arachnida, pass through a sort of *moulting*. Previous to this change of skin, they always contract all the moveable parts of the body, resign themselves to repose, and remain benumbed and stiff in the hindermost blind extremity of the gallery. The contents of their body form an amorphous mass, as in the egg, during its segmentation. We usually count three such changes of skin. From the first moult the hexapod mite comes forth with eight legs; everything else, even the processes, remains the same in all stages. Before each change of skin the skeleton of the mite is darker and harder, the head and extremities are smaller in proportion to the body, and the whole animal in better condition and fatter. After this change the skeleton is softer and paler, the head and extremities larger in proportion to the body, and the animal is not so fat.

Besides this change of skin, the octopod mite undergoes a further moulting, from which it issues again without sexual organs, which it only obtains after the third change of skin. Older females, which have remained unimpregnated, wander out of their passages, shrivel up, and take up a position as before moulting. Whether these pass through another change of skin is unknown.

The cast skins remain lying rolled up together in the passages. After the first and second changes the female mites wander out and bore themselves new galleries, but after the third, they mine further on in the gallery in which they have changed their skin, until they are sought out by the male. The size of a female mite in its first change of skin is $\frac{1}{11}'''$, in the second $\frac{1}{8}'''$, and in the third $\frac{1}{5}'''$; the males are proportionately smaller.

The act of copulation was seen by Worms, who states with regard to the males in general, that they like to be in the vicinity of the galleries of mature females. The male creeps, as in the lice, under the belly of the female in such a manner that the

two ventral surfaces are in contact, the dorsal surface of the female touching the corresponding spot of the upper, and that of the male the lower wall of the canal. To judge from corresponding proceedings in other mites, however, the male only passes with a small portion of his abdomen under the end of the belly of the female, and would have no hold during the act itself, if the female did not embrace the male with the long bristles of her hinder feet, and the male the female with the bristles of his third pair of feet, and at the same time attach himself firmly to the ventral surface of the female with the sucking cups of his last pair of feet. The males never penetrate into the galleries of impregnated, egg-laying females, as is shown by the unbroken series of the eggs.

Of the duration of the life of the mites in their particular stages of development, Gudden gives the following calculation: The hatching time of the eggs lasts about eight days; on the seventeenth day after transference hexapod broods in the act of moulting are found, in forty-three days female mites after their last change of skin, and in forty-eight days the first egg-gallery with eggs. We may therefore reckon somewhat in this manner: eight days, hatching time of the eggs; duration of each change of skin six days, interval between them five days; which gives as the commencement of the first change of skin about the fourteenth day, of the second the twenty-fifth day, of the third the thirty-sixth day, and of the oviposition the beginning of the seventh week. If the males die soon after copulation, they would attain an age of about six weeks.

Mode of infection of itch.—Gudden first discussed this question rationally in accordance with the desire of wandering at the different periods of life. The most restless are the males seeking after females, and next to these the young; these, therefore, are the most easily transferred; lastly, just fertilised females after the third change of skin, which wander out of their old passages, in order to dig new ones for themselves, in which to lay their eggs. Females already engaged in oviposition, or near it, can rarely, if ever, be the cause of itch, as they never leave their galleries again. It is only in deep-seated itch that these last may perhaps be transferred from one place to another on the body of the same individual. Hebra and Gudden do not coincide with the opinion defended by Von Liebig and Bourguignon, that the itch-mites are nocturnal predaceous animals; they regard the wanderings of the mites as solely and wholly dependent upon

warmth, as I myself had previously stated in Günsburg's 'Zeitschrift.' Dancing, the long junction of the heated hands of the dancers in warm ball-rooms (but not every simple contact of the hands), the carrying of young children by itchy nurses (when the latter lay their bare hands upon the nates of the children), sleeping with itchy subjects, or taking possession of their beds whilst still warm, and putting on clothes and linen which they have just worn, are the principal agents of infection. In general, however, there is too much fear of wearing clothes which have been long left off by the patients. Even the greatest cleanliness is no protection against the itch, of which I am one of the most convincing examples, as notwithstanding my daily custom of washing my body morning and evening with soap and water, I was infected when a lad of seventeen on a holiday journey towards home.

The summer alone perhaps furnishes no favorable momentum for the infection; but this is perhaps only apparent, because common people prefer going into the hospital in the idle time, as Schinzinger has already mentioned. Men are affected much more than women, on account of their occupation (in the proportion of 12 to 1). The seat of the disease also varies according to the sex. Men are very soon and readily affected on the penis; women rarely in the generae organtivs; but the itch is very easily communicated from infected nurses to the genitalia of children in arms. The more delicate the skin, the more is it disposed to infection. Whether a certain degree of hairiness facilitates the transfer, as mites willingly climb upon hairs, is a question still undecided, the investigation of which I have already suggested, and in favour of which the more frequent occurrence in men is an argument. Schinzinger, Hebra, &c., have prepared the following table according to trades, descending from the most favorable occupations to those less favorable: tailors, shoemakers, joiners, male and female servants, day labourers, and factory labourers (the last three denominations in pretty equal numbers), girls of the town, bricklayers, book-binders, paper-hangers, bakers, hatmakers, tanners, whilst the soap-boilers, according to Schinzinger, are quite free, and it is well known that potters are very rarely attacked.

The geographical distribution of the itch is universal, in south and north, in inland districts, and on the sea coasts (Greenland, the coasts of Schleswig-Holstein in the last war), and both in the Old and New worlds.

The diagnosis is possible in all cases with a lens and the microscope, but without them completely impossible in many cases, or a mere piece of luck, which a conscientious surgeon should never allow to have any dominion over him in cases where he has the means of a diagnosis. Suspicion is excited in dirty cases, by nocturnal itching, increased by warmth, with eruption of vesicles and papillæ. The diagnosis is founded upon the detection of the gallery of the mite with the balls of excrement, eggs, or remains of the mites, by the aid of the microscope. By the latter, and by this alone, even those cases are recognised in which it does not come to reaction, or in which the formation of galleries retrogrades, as is sometimes the case in the so-called Norwegian itch.

Therapeutics.—The only indication is that of killing the mites, as there can hardly be cases of spontaneous cure. The attempt at attaining this object by internal remedies is mere folly. Such a process is only introduced now-a-days by quacks, ignoramuses, or pick-pockets, and should be punished by the authorities on account of the infection to which others are exposed by such a treatment of the disorder. The destruction of the mites is the first and principal object of the treatment, and that remedy is the most deserving of recommendation which causes their death with the greatest rapidity, and with the least inconvenience to the patient. We need never despair of this destruction and the cure produced thereby. Even very old cases rapidly yield to treatment. But if in a particular case we should be in dread because the long existence of the disease has led to habitual secretions, of the sudden suppression of which by the rapid cure we are frightened, it is only necessary to maintain a fontanelle or an artificial sore for some time, and allow this to heal up slowly. Usually, however, this is quite unnecessary. (See Langenbeck, 'Bericht der 24 Versammlung der Naturforscher zu Kiel,' p. 161.)

The remedies fall into three series:

1. *Those which remove the mites mechanically*, to which I have given the name of *Itch-mite-combs (Krätzmilbenkamme)*, a series of remedies, with regard to which I have been so misunderstood by Gudden, that I cannot but think that he has not read my essay, referred to by him, upon the testing of the rapidity of the remedies as regards the destruction of the mites;

2. *The remedies which have a chemico-physiological action upon the mites and kill them* (Antisarcoptica);

3. *Combinations of the first and second methods.*

I. Remedies which remove the mites mechanically (*Milbenkämme*), and methods founded upon them.

a. Picking off the mites.—This plan is still in use in Corsica; very deserving of recommendation, according to Hartwiz and Walz, with the large mange-mites of animals (*e.g.* horse-mites), and also effected by König with the *Sarcoptes hominis*, and recommended by Schinzinger for those perfectly fresh cases in which only a few galleries are found. To effect this picking (especially in the latter case) we have simply to cut out or slit up the entire passage, capture the mite, and then apply caustic to the place. In general, however, this method is too tedious, and in old cases even dangerous as a point of medical police, from the prolonged danger of infection.

b. Rubbing off the mites with charcoal, chalk, brick-dust, fine sand, pumice-stone, &c.— This plan is too tedious alone, and allows too much chance of diffusion; in combination with other methods it is deserving of consideration.

c. The removal of the passages with their inhabitants (mature mites, brood, and eggs) *by the cutaneous inflammation produced by soft soap.*—This method is especially represented by the old, English, Vezinian method, which has hitherto been the one most in use. In this the patient is treated with soft soap from top to toe, with the exception of the penis, which is carefully protected by cloths; this treatment is continued for eight days, during which he is kept at a temperature of 100° F. (30° R.). He is then laid naked between woollen blankets until the inflamed epidermis breaks off in fragments. Circumstances enough to render it desirable to do away with this method are to be found in the great inconvenience which it inflicts upon the patient, the troublesome eczema which is scarcely ever absent, the injurious employment of the method only in the summer time, the long duration of the treatment itself, which is still further prolonged by the frequent relapses (caused, according to Volz, by the penis, a principal seat of the mites, remaining entirely out of treatment, and thus furnishing a fresh source of infection), in the great expense caused by the soft soap, the heating, and the purchase of the blankets, in the impossibility of applying the method out of the house of the patient, and in the disgusting nature of the method itself.

d. The removal of the mites by the external application of Sulphur-remedies, known even to Celsus, which, from my experiments in killing the mites, I cannot reckon amongst the *anti-sarcoptica,* as mites lived for days in such remedies as the simple ointment of flowers of sulphur. That they cure the itch, there is no doubt. They can therefore only act by the production of cutaneous inflammation, like soft-soap, and consequently also belong to the "Milbenkämmen." The methods here coming before us are various, partly simple, partly complicated, as every one will see from what follows, and every one may select his remedy accordingly. Here belong:

α. *Horn's method,* recently praised by Jenni, of Glarus.—1 part of flowers of sulphur and 2 parts of soft soap diluted with soap and water and rubbed in. Soap baths are also prescribed. In very inveterate cases Horn gives baths of sulphuret of potassium, an ointment of iodide of sulphur (12 grains to 1 ounce of lard), and purgatives.

β. *The method of Tilly of Courtrai.*—100 parts of flowers of sulphur and 150 parts of lard are heated until the sulphur is completely melted, and then 150 parts of black pitch, and 100 parts of soap are added. First of all a bath of one hour is given, then the ointment is rubbed in three times a day for two days, and on the third day a tepid soap-bath. No subsequent diseases were observed.

γ. *Hebra's method,* of which the one just mentioned only appears to be a modification. The patients are first of all washed at the ordinary temperature of the sick-room, and then every evening and morning, for two days, rubbed with an ointment composed of sulphur, pitch, lard, and a little pounded chalk, but only on the places where the galleries of mites and vesicles occur (therefore, particularly on the hands, feet, penis, breasts, navel, and buttocks.) The sheet is then drawn close up under the arms, and the hands rolled up in it, so that the patient may not transfer the ointment to other parts of the body. On the third day the patient washes himself in his room with tepid soap and water, in order to avoid the eczema, which otherwise easily follows the bath. He then takes a bath, is watched for a day or two, and discharged if no fresh erruptions occur. The process is cheap, certain, and tolerably short. The principal point consists in avoiding the eczema, which is not very difficult, according to Schinzinger, and was also managed formerly by Hebra. To me, the rolling up in

the sheet seems too complicated, and if the greatest care is not taken, insecure. A sort of sack tied round the neck, trousers or strait-jacket, or wrapping the sheet up to the neck, and putting on linen sleeves sewed up at the fingers, appear to me to be more advisable.

II. For ages, as at the present day, all sorts of acrid, caustic, and poisonous materials, out of the vegetable, mineral, and animal kingdoms (the urine of men, horses, &c.), have been prescribed with the view of killing the mites. We can hardly expect much from the latter, as the animals live a long time, even in concentrated solutions of the soaps. Hence, also, washing with common soaps (Schinzinger) can hardly do anything, even in slight cases, as I know from my own experience. Little is also to be expected from washing with sulphide of magnesium (Van den Corput). From my experiments, as also from those of previous authors, such as Albin Gras and Hertwig, the essential oils, such as oil of turpentine, anise, and rosemary, are to be preferred to everything, as rapidly destructive remedies against horse- and cat-mites. In the presence of Professors Kobett and Hecker, and of Prosector Maier, Schinzinger, confirmed my statements with regard to the oils of anise and rosemary upon the mites of the human subject. The mites die within sixteen minutes in oil of anise; still earlier in oil of rosemary. At Berlin it has been urged against oil of anise that it excites too violent inflammation; an objection which it certainly does not merit, as is proved by the observations made, shortly after the war in Schleswig-Holstein, at Travemunde, where the remedy became again quite a popular one, upon the recommendation of the bath-surgeon at that place, Dr. Liebholt, who advised it in consequence of my memoir, and was further confirmed by the observations made by Dr. Mittrich and myself at the same place, and by those of Dr. Schinzinger. If the charge of extravagance has been made against the remedy (and an esteemed hospital surgeon let me know by a patient sent to him, that my itch-medicine might be good, but that it was enormously dear, as he had employed oil which cost, I think, several dollars in a single cure), that is not my fault. I have recommended essential oil at 6*d.* to 10*d.* per drachm, a clear proof that I did not refer to a perfectly pure, expensive, essential oil. For the cure it is sufficient to add to olive oil or almond oil a few drops of the strongest essential oil, and to mix them with the

assistance of a gentle heat, for the purpose of obtaining a better diffusion. In consequence of my statement regarding oil of anise, Jähne, of Berthelsdorf, brought rosemary oil, which does not smell so strongly, into use. Its efficacy against the mites has been confirmed both by Schinzinger and myself. I do not know how it is that Schinzinger finds fault with the remedy because it has an unpleasant odour, and acts injuriously upon the lungs and chest. The former I have not found to be the case, and the latter may be avoided, by allowing the patient to move about for a little while in the open air or at an open window. But however this may be, both oil of anise and oil of rosemary are good destroyers of mites (not "Milbenkämme," as I have said, according to Gudden), and I am firmly convinced that they will gain friends. All that is necessary is to give a bath, and have the patient rubbed in the bath on the affected spots and over the whole body with the coarsest pumice-stone soap, in order to tear open the galleries and pustules, and then, after good and sufficient drying, to rub in the oil; or the skin may be rubbed with the pumice-stone soap without a preliminary bath, and afterwards with the oil. From my observations, also, no further disinfection of the linen is necessary, as any mites which may exist in the clothes are also killed by the oil. As the eggs require eight days for their development, I advise, in order to avoid relapses, that during the first 8—14 days the oil should be rubbed in from time to time every five or eight days. (See Volz upon Upmann's method.)

Very recently the oil of turpentine, which was also tested by me as a mite-killer, has been brought into use by Upmann, in the Military Hospital at Karlsruhe. He lets the itch patients bathe, and then for five days rubs oil of turpentine twice a day into the whole body (which is superfluous according to Volz, as a single rubbing is sufficient to kill the mites), bathes them again on the seventh and eighth days, and eight days afterwards makes them show themselves again in the hospital, and rubs them again with turpentine. The itching and irritation of the skin usually cease after the first two rubbings in; the galleries are uninjured, their vicinity reddened, and the mites dead. As troublesome secondary cutaneous eruptions often follow, and the passages never go away entirely, but only dry up, we have no positive certainty that a cure has been effected. At the same time the oil of turpentine cannot destroy the power of development in the

eggs, but only suspends it, and hence relapses occur after six, eight, or even twelve weeks. According to Volz, it would be rational to effect a rubbing on the first, tenth, and twentieth days, and to take baths in the intervals, as in this way any brood excluded subsequently would be killed, and their development to maturity prevented. In general, this process is not adapted for a hospital treatment, but furnishes a good preliminary treatment.

The oils here referred to are interesting in a physiological point of view, as they prove that the mites must possess a respiratory organ, through which their poisonous action upon the animals is communicated.

Solutions of *Delphinine* have not proved to be *Antisarcoptica* with me. Nor do I expect anything from the Tinctura Staphisagriæ, nor from the powder of the seeds of the same remedy, notwithstanding Bourguignon's recommendation, as the mites do not certainly die in them.

With the action of the *Tinctura Tabaci,* and of the solution or extract of the so-called insect-powder (see Lice), I am unacquainted.

I now come to the method which is at present most widely and generally diffused, *Hardy's rapid cure* and its modifications, which I place here, because the principal agent in it is certainly, as Volz first stated, the carbonate of potash, or the alkaline sulphuret which may be formed, in which the mites soon (within a quarter of an hour) become pale and transparent, and die.

The method introduced by Bazin and Hardy is only a repetition of that employed by Bourdin, as early as 1812, at the hospital of St. Louis, in which Helmerich's ointment, which still maintained its ground at this hospital, plays a principal part. Bourdin first of all gave a purifying bath, and at the same time had soft soap rubbed into the whole body for half an hour; 2dly, on the next day he had the whole body rubbed three times with Helmerich's alkaline sulphur-ointment (8 parts of lard, 2 of sulphur, 4 of carbonate of potash); and 3dly, on the second day he gave a purifying bath of soap, after which the patient was discharged as cured. Hardy abridged this process essentially. After the rubbing in of soft soap for half an hour, the patient goes into the bath, where he is again rubbed for an hour with soft soap, and after the bath for half an hour with Helmerich's ointment. In this way, according to Volz, 3—4 ounces of ointment and a pound of soft soap are used to one patient. Unfortunately, this method affords no protection against relapses, produces extensive eczema, and even

febrile eruptions of vesicles and pustules. Hence the medical profession was divided into two great camps, one of the opponents of this method (Hebra, for example), and the other of its supporters (Volz, &c.), who, recognising its great value, endeavoured to improve it by modifications. We must, at the same time, take into consideration that this method cannot be equally well carried out anywhere. It appears to be best adapted for strictly disciplined military hospitals. In the French regimental hospitals the patients are rubbed in the bath for three quarters of an hour with seventy grammes of soft soap, and after the bath for a quarter of an hour with Helmerich's ointment; this is repeated in a few hours, and followed by a cleansing bath.

Hardy's rapid cure experienced a modification from Fronmüller, of Fürth, who first introduced it into Germany. According to him, sulphur is the principal agent in Helmerich's ointment; whilst Volz, supported by my experiments, considers the carbonate of potash as the principal agent. The former says that the common English itch-ointment may also be employed in the rapid cure. The principal point is that the rubbings in should be effected with perseverance, energy, and with especial stress upon the favorite habitations of the mites, for which purpose the patient must be assisted by the nurse. Fronmüller allows the ointment to remain adhering to the skin for an hour, during which the patient may remain sitting in a woollen coverlet. Then follows the cleansing bath and the dismissal. Any patches of eczema heal of themselves within forty-eight hours. As, according to Fischer, of Cologne, Fronmüller's method does not furnish sufficiently good results, he recommends the following method, which is also extolled by Keyl, and less celebrated by Schillingen (who once saw a relapse after it, and once agitation and fainting during the treatment). 1, a short soaping with ℥ij of green soap; 2, a bath for an hour at 27°—28° R. (92°—96° F.); 3, after careful drying, rubbing in with caustic potash (℥ß of potash is heated with ℥iv—vj of water, and rubbed with a ball of tow into the whole body of the patient, with the exception of the face, and especially into the extremities, for $\frac{1}{2}$—$\frac{3}{4}$ of an hour, by gloved nurses); 4, a short soaping in a tepid bath; and, 5, general cold shower bath. Küchler, of Darmstadt, praises this process.

Lastly, one of the warmest defenders of the quick cure is Volz, who saw no relapse in thirty-two cases. According to him, the action of the treatment upon the skin is as follows:—Most of

the vesicles are deprived of their epidermis, the folds of the skin and galleries of the mites are filled with sulphur, the cutaneous inflammation here and in the vicinity, however, is but small, and on the third day the vesicles, as well as the inflamed passages, are dried up. Volz, however, only allows his patients to bathe on the fourth day, by which means the passages of the mites are completely thrown off, and are then got rid of. The first rubbing in only serves to cleanse the skin, but does not kill the mites; this is only effected by the alkaline sulphur ointment, in which the mite becomes quite transparent within a quarter of an hour, swells up, and dies. The crystalline sulphur destroys the passages, the ointment causes them to be thrown off, by which means the dead mites with their eggs are got rid off; of the latter we do not know whether or not they lose their germinative faculty with the ointment. However, even Hardy did not employ his method in those cases in which the itch is complicated with inflammatory eruptions. In these cases Hardy and Gibert resort to the *Tinct. Tabaci* and *Staphisagr.* diluted to one half, and belonging, according to their views, to No. 2.

The *Belgian* rapid cure, so-called by me, because it is introduced into the Belgian army, consists in a similar process. The patient is first rubbed for an hour with soft soap, then for another hour and a half in the bath, and after the bath with 60—90 grammes of the cheap sulphide of calcium. The latter remedy is also recommended by Piorgey. I place this method in this position for the same reason as Hardy's.

III. *Methods combined from* 1 *and* 2.—Here belongs the method of Hardy, just referred to, in part, and that described by Schinzinger in his 'Habilitationsschrift,' which is made use of at the Surgical Hospital in Freiburg. If there are galleries in the ordinary places, the patient or the nurse is instructed to rub these places three times a day, for one or two days, with an ointment of green soap, pounded chalk and water, without observing any particular precautions with the sheet (Hebra) in lying down in bed. The chalk tears open the passages, knots, and vesicles, but the soap causes the passages to be thrown off by inflammation and formation of exudation. On the third day follows a bath. After this, the places where the mites lay are rubbed with $\frac{1}{2}$—1 drachm of oil of anise, and ʒj of alcohol, which produces a fleeting pain for a few minutes.

If the individuals be dirty, the skin callous, and the case old, a bath is given, in which the patient washes himself with soft soap, by which the skin becomes softer, and the galleries more visible. Then follows the treatment just described, with the precaution of telling the patient and the nurse the places which are particularly inhabited by the mites, and which, therefore, are to be specially rubbed. In all cases the penis must be rubbed in with soap, but the flexures of the arms and lower extremities should be left free, as here the soap readily produces eczema. After the completion of the treatment, a fresh examination is necessary in order to see whether all the passages, nodules, and lumps are destroyed. Should this not be the case, and should new passages with fresh excoriations be produced, the repetition of the treatment is necessary.

If the patient comes under treatment with eczemata, sores, or excoriations, these often remain long after the extermination of the prurigo, which usually takes place within two or three days. They are to be treated with cold poultices, solutions of corrosive sublimate, &c.

I think, however, that if we modified Hardy's rapid cure by adding about ʒj of oil of anise to Helmerich's ointment, we should attain more certain results, and thus avoid relapses; the latter especially, by giving the patient, on his dismissal, a portion of oil of anise or rosemary, to rub in every eight or ten days for about four weeks upon the places most affected, or where any itching may occur, or vesicles make their appearance. In order to avoid relapses, it is always advisable to disinfect the linen. The body-linen (shirts, drawers, and stockings) should be boiled, washed, and dried, during the three days' treatment in the hospital. The other clothes (coats, trowsers, hats, and caps), and also the portemonnaies or purses, with the money in it, and in the case of journeymen artisans, even the knapsack, should be disinfected either with fumes of sulphurous acid (which, it is remarkable, is still the case in the French army, although the colours of the clothes, or even the clothes themselves, readily suffer injury by this means, and smell of sulphur long afterwards), or by a degree of heat which does not attack the clothes, but destroys the mites (according to Fischer, 90° C.=194° F.) For this purpose the louse-oven or any baker's oven is well adapted. The disinfection by heat is generally introduced into the Belgian army. Or the clothes may be boiled in steam. Some, as Volz,

think it is sufficient to beat the clothes heartily, to brush them in particular places (cuffs, button-holes, and pocket-holes) with soap and water, and sprinkle them with turpentine, which immediately kills the mites. According to Volz the mite can only live one or two days out of the body; according to others it may live three weeks. How long the eggs retain their power of development out of the body is unknown.

Shall I say one word upon the retrocession of itch, and the diseases supposed to be produced thereby? Shall I trace this unlucky theory of the otherwise so meritorious Autenrieth from its origin to the time when Hahnemann and his disciples published a caricature of these views in their psoradic theories? The mainstay of this absurdity is now broken, and I pass it over. I may be allowed, however, to mention one case as an example of the mode in which this subject is sometimes treated. Joachim relates: "A girl, eighteen years old, was rubbed with ointment for the itch, and confined in a *hot oven* for an hour and a half, upon which she became blind. By means of sulphur and derivatives applied to the skin, the itch returned again, and the power of sight in five weeks." In this case who would not seek the cause of the blindness rather in the heat of the oven than in the retrocession of the itch? I would not advise Herr Joachim to make the experiment, whether he would not also become blind, after supporting the heat of an oven for an hour and a half, with a healthy body, whether anointed or not!

Mites accidentally transferred from Animals to Man.

Although a short time ago Bourguignon left the transferability of the mange-mites to man as undecided, we, in Germany, have long been convinced, by the thorough-going experiments of Hering, Hertwig, and others, that such transfer does take place—that passages are actually bored, and itch-like eruptions produced, in the human skin by these animals. In general, however, these eruptions only last as long as the individual life of the mites transferred. Upon this point, nevertheless, the accounts of observers still vary, some extending the period of its visit to two or three weeks, and others to six weeks and more. It does not appear possible for these animals to pass through their whole development upon the human subject. And if this is the case, I believe it only takes place in those species of mites

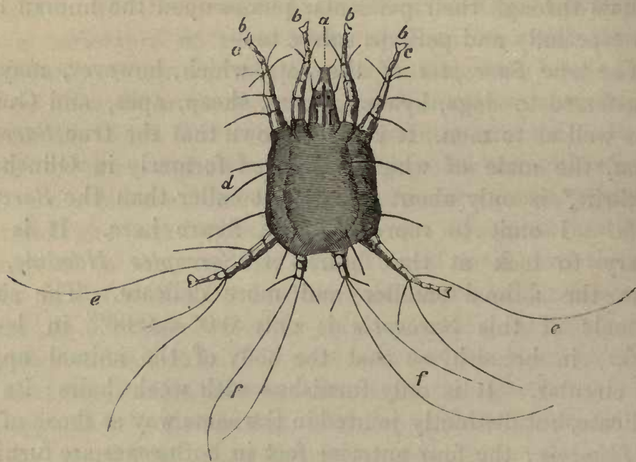
which resemble the true *Sarcoptes Hominis* in structure, and only differ from it in size. In this case we must beware of errors which may easily be produced by our not noticing the constant fresh, perhaps daily, infection taking place during the long contact of mangy animals with the same human individual; and supposing, from the long duration of the animal-mange upon the man, thus caused, that the specimens of the mite found have grown large upon the man, whilst they have probably, in general, only been transferred to him a short time before. What has been said of the possibility of a development of the mites of animals through their particular phases upon the human body, applies especially and perhaps solely to—

1. The true *Sarcoptes* of the cats, which, however, may also be transferred to dogs, hyænas, bears, sheep, apes, and Guinea-pigs, as well as to men. It is well known that the true *Sarcoptes Catorum*, the male of which I figured formerly in Günsburg's 'Zeitschrift,' is only about one half smaller than the *Sarcoptes Hominis*. I omit to reproduce the figure here. It is only necessary to look at the figure of *Sarcoptes Hominis*, and imagine the animal smaller and more delicate. The size of the female of this *Sarcoptes* is only 0·05—0·06''' in length, and 0·05''' in breadth, so that the body of the animal appears almost circular. It is only furnished with weak hairs; its feet are delicate, but distinctly jointed in the same way as those of *Sarcoptes Hominis*; the four anterior feet in both sexes are furnished with suckers; in the female the two posterior pairs are each provided with a long bristle, and without a sucker; in the male the third pair with a hair, and the last with a sucking cup on each foot. Recently Bourguignon has described the transfer of the mite of the lion to man, and *vice versâ*. This mite is said to be larger than the cat-mite, and exactly like that of the human subject. It now becomes a question whether the mites of the cat, lion, and human subject are not perfectly identical, and only attain a different size according to the animal which they inhabit.

2. *Sarcoptes Canis*.—Even Sauvages ('Nosologia,' Amstelod., 1763, ii, p. 464) and Viborg speak of a *Scabies canina* = dog's itch, in the human subject; and Hertwig saw two boys infected by a mangy dog. The dog's mite has a great similarity to the horse-mite, except that the former is smaller and has far stronger hairs, which even appear plumose, on the sides of its body.

3 *a*. *Sarcoptes Equi* (figs. 1 and 2).—The males of this pretty large species, which is visible with the naked eye, are about $\frac{1}{15}'''$ in length and breadth, resembling a square, notched at its four angles; arched on the back and belly, tolerably thick; the body covered with alternate furrows and raised lines, running transversely on the back and on the abdomen in a semicircular form, or even longitudinally, by which the skin acquires the appearance of shagreened leather (like morocco leather).

Fig. 1.



a, the head; *b*—*b*, the anterior feet; *c*—*c*, the sucking disc or sucking lamina on the last joint; *e*—*e*, the outer, *f*—*f*, the inner posterior feet.

On the back we see some small tubercles, and towards the front a long, stiff hair. On each side of the body, at the commencement of its posterior third, there also stand a long and a short hair. According to Raspail and Hertwig there only appears to be a chitinous framework for the two anterior pairs of feet, at least it is not referred to for the posterior feet.

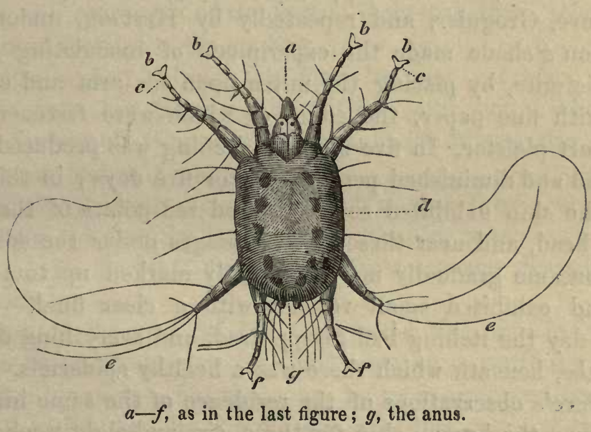
The head is conical or proboscidiform; its length is one third of that of the body, and its thickness not very considerable. Above the proboscis, two nipper-like moveable spines lie horizontally and close together. Between the proboscis and the spines, a very thin, capillary organ sometimes projects. Close to the origin of the spines, there is on each side a fine, stiff hair; behind this a second; and then a round point, with a dark out-

line, which is regarded as the eye. Then follows the neck, with several red points on the ventral side.

The anterior feet, which are as long as the breadth of the animal, diminish in size towards their free extremities. Each foot has four joints. Each of the first joints bears a pretty long hair, the third two shorter ones, and the fourth three hairs, a sharp, curved, horny claw, and a sucking disc upon a tolerably long three-jointed stalk, for which reason the feet have been referred to as composed of six joints. Of the posterior feet of the male the outer third pair is as long as its body, and as strong as one of the anterior feet with a sucking lamina. The hairs with which this pair of feet is beset are extraordinarily long and strong. The inner (fourth) pair is very short, and weaker than the third pair, without sucking discs, but furnished with a pair of long hairs. On the abdomen we find the anus between two verrucose tubercles, strongly clothed with hair. The male generative organs also appear to lie in the vicinity of this.

The females, which are far more abundant, only differ from the males in their size and in the structure of the two posterior pairs of feet. The female is about one third longer ($\frac{1}{9}'''$) than the male. The two posterior pairs of feet are attached to the belly,

Fig. 2.



a—f, as in the last figure; *g*, the anus.

close together, of equal length and strength, but shorter and weaker than in the male. The external (third) pair of feet has two long, terminal hairs, but no sucking disc; the internal

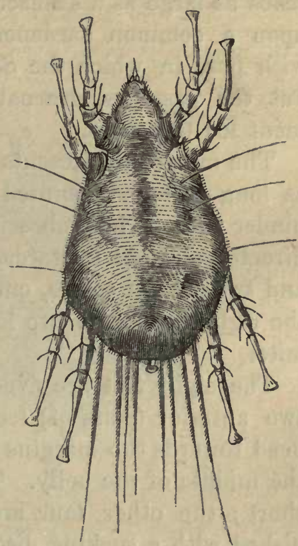
(fourth) pair has the rudiments of a claw, a sucking disc, and a fine terminal hair at the base of the stalk of the sucking disc. The hairs and tubercles at the anus are smaller and more rare. The generative organs are not exactly known.

The colour of the animal is whitish; the horny skeleton reddish-brown, ferruginous. The eggs are very large, coated with a sticky mass, and are often carried about by the female between her legs. The eggs are deposited in small galleries under the epidermis. The young are very small, but grow very quickly during the first four days; and, according to Hertwig, they have their eight feet at once, but only six according to Hering, so that they also undergo a change of skin. Their movements are effected quickly, and by means of the feet provided with sucking discs. They may be kept alive for three weeks without nourishment. Wherever they penetrate into the skin, a small, knot-like elevation is produced, with a small passage, at the extremity of which the mite sits. The epidermis becomes soft, separates by exudation from the cutis, and dries, in animals, into scaly scurfs, which become detached. All these mites produce, in animals, similar phenomena to those presented by the Norwegian prurigo in the human subject.

The transference of the mite to man has been proved by many observers, as, for example, E. Viborg, Sick, Sydow, Osiander, Greve, Groguier, and repeatedly by Hertwig, under whose inspection Schade made the experiment of inoculating himself with this mite, by placing the mites upon his arm and covering them with fine paper, the edges of which were fastened down with court plaister. In five minutes, itching was produced, which increased and diminished periodically for five days; in thirty-two hours the skin exhibited several raised red points of the size of a pin's head, and near these small passages under the epidermis, which became gradually more distinctly marked up to the fifth day, and exhibited small vesicles with a clear fluid. On the twelfth day the itching had disappeared, and everything dried up into scabs, beneath which there was a healthy epidermis. Whether Greve's observations of the residence of the same individual mites upon the human skin for three, six, and eight weeks before healing took place, be an error in the above-mentioned sense, I am unable to decide. Greve and Hertwig also saw the transfer of the disease from one man to another, notwithstanding that the mites do not propagate upon the human body.

Besides the species of mite just described, a second species has occurred, according to Hering, in the gangrenous sores of the hoof of a horse,—namely, *Sarcoptes hippopodus* (fig. 3). Hering says of it, that its body is twice as long as broad, beset all over with small hairs, like satin; head retractile; proboscis consisting of two valves moving laterally; mouth directed rather downwards; close to it two small palpi; feet eight, five-jointed, the last joint as long as the four preceding, with a small sucking disc at the end, and two small hairs on each joint. Two pairs of the feet originate near the head, and two posteriorly on the belly. On the abdomen a small prominence, and four long, straight, plumose bristles; their length 0·16, their breadth 0·08—0·085‴. The three pairs of bristles on the back, and those at the abdomen, can be raised like the tail of a peacock. The large bristles are plumose; the hairs on the joints of the feet diminish in length towards the extremity of the foot. Only the third joint of the first pair of feet has a longer hair.

Fig. 3.



On the human subject this form has not yet been detected with certainty, but Hering thinks it has some similarity with the *Acarus favorum* of Hermann. A peculiar mite was also found in sores of the foot of a horse.

4. That the *Sarcoptes Bovis* first observed by Gohier upon Hungarian oxen in the last French war, also passes over to man has long been doubted, until Thudichum recently described such cases with certainty.

A peasant believed he had transferred the mite to his upper lip from the cattle treated with ointment, by incautiously scratching under his nose. On the upper lip were produced coalescent, dark-red scales, vesicles, knots, and pustules elevated above the skin, of various sizes, but of uniform hardness, which made their appearance suddenly in the vicinity, and at last occupied the whole lower part of the face, including the throat. The vesicles, which were filled with white serum, sat upon a hard, red base;

some of them had turbid, purulent contents. The pustules were very small or larger, so that they covered themselves with thick scabs as large as a kreuzer. They also stood together in groups, upon a common hardened base and exhibited fistulous passages with pus, in which the *Sarcoptes Bovis* were found. Syringing out the passages, evacuation of the matter, and mercurial ointment led to a cure.

The mite itself presents the following peculiarities. It is twice as long as broad, pointed towards the head, rounded off at the hinder part. The proboscis consists of two jointed superior valves, directed straight forwards, of two central, spiniform, thin palpi, and two inferior valves, curved in the manner of a retort, of which the right one bears two long bristles. Hering has not seen this mite.

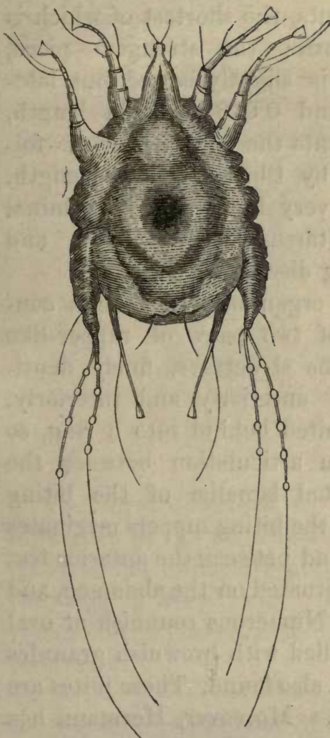
The eight feet are five-jointed, arranged in two groups. The two anterior (pairs of) feet originate beneath and close to the head towards the margins of the body; the posterior feet behind the middle of the belly. The first joint, attached to the belly, is short; the other four are tolerably equal; and the last is furnished with a sucking disc. Every foot bears two short hairs on each joint, but the third joint of the first pair of feet has a stronger and longer hair. The entire body exhibits a number of stronger, uniformly distributed, bristles, springing from separate warts or papillæ; on the abdomen there are twelve large ones, without reckoning the smaller ones. (See Rubner's Illustrirt. Zeitung, i, 5, 1852.) The figure of the cast skin of this mite here given is omitted by me.

5. The *Sarcoptis Ovis* (figs. 4 and 5), first correctly described by Walz, is similar to the horse-mite, but smaller (0·16—0·22‴ in length and 0·16—0·17‴ in breadth), moderately hard; the male is roundish, the female more oval. Each of the external posterior feet has two long bristles; the fourth pair of feet in the male is rudimentary. The horny framework of the feet is reddish-brown. They bore passages beneath the epidermis, from which the little hexapod brood, which grows quickly and becomes octopod, issues in from about eleven to sixteen days. This mite has been seen but rarely upon man; Hertwig's experiments in inoculation gave no results.

Apparently very similar to the last-mentioned mite in structure is the species of *Acarus* found by Willigk in Favus crusts, although it approaches the *Dermanyssi* in the want of bristles

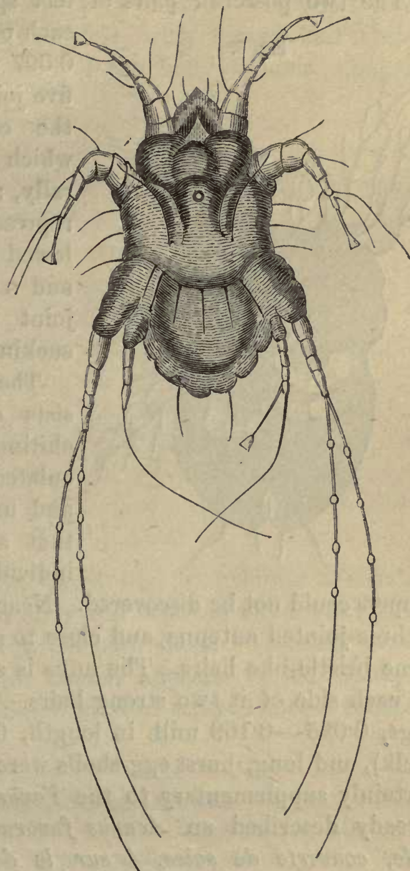
at the extremities of the feet, and in the clothing of all the feet with small hairs. The crusts in which the animal was

Fig. 4.



Sarcoptes Ovis, from above.

Fig. 5.



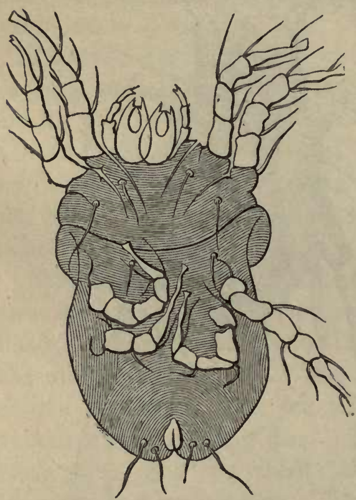
Sarcoptes Ovis, from beneath.

found, had already lain for a long time, and consequently only dead animals, filled with fat or with Favus-fungi, were seen. The animal was oval, had a prominent conical head and a rounded hinder part; it was 0·116—0·252 mill. = $\frac{1}{20}$—$\frac{1}{10}'''$ in length, and at the lower extremity of the cephalothorax, 0·084—0·132 mill. in breadth. The cephalothorax widens behind, and extends somewhat beyond the abdomen laterally, in the form of a pilgrim's collar; the brittle skin exhibits a regular undulatory

marking, which rather disappears as the parasite imbibes. Scattered hairs are to be seen springing from pores or little warts (fig. 6).

The two posterior pairs of feet spring from the belly close to each other. Each foot is 0·089—0·097 mill. in length, and presents five joints, the shortest of which is the coxa; the strongest piece, which is slightly bowed out laterally, and 0·018 mill. in length, represents the femur, which is followed by tibiæ, 0·015 in length, and a very long, conical terminal joint (tarsus) with a stem and sucking disc.

Fig. 6.



The organ of manducation consists of two pairs of nipper-like chitinous structures, finely denticulated anteriorly and interiorly, and united behind into a ring, so that an articulation between the individual lamellæ of the biting nippers could not be discovered. Near the biting nippers originates a three-jointed antenna, and close to and between the anterior feet some bristle-like hairs. The anus is situated on the abdomen, and on each side of it two strong hairs. Numerous roundish or oval eggs, 0·025—0·169 mill. in length, filled with brownish granules (yelk), and long, burst egg-shells were also found. These mites are certainly supplementary to the *Favus*. Moreover, Hermann has already described an *Acarus favorum*. "*Mite ovale, convexe, pâle, couverte de soies*, 4 *sur le derrière du dos, dressées en haut et étalées.*" Hering compares it with the species of *Sarcoptes* mentioned under 3 *b*.

We have still to refer here to a similar occurrence, namely, that of the mites in a case of plica polonica. Hessling narrates (Rubner's 'Illustrirti Med. Zeitung,' i, p. 5, 1852), that, together with innumerable lice, he accidentally found some mites not peculiarly belonging to the disease. I pass over the first form entirely, because it is much too imperfectly described, as Hessling only found fragments of it, which appear to me to look very little like a mite.

The form described by him as the second form has an oval body, crooked when dead, terminating in a pointed head, without any neck. The nippers are hollowed out like shells, and strongly denticulated on both sides; the feet six-jointed, with small, gently curved claws, and beset, like the body, with longer and shorter bristles, which towards the end of the body become elongated and sit upon small knobs (fig. 7).

Fig. 7.

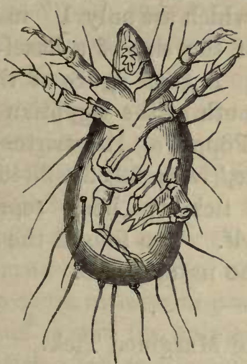
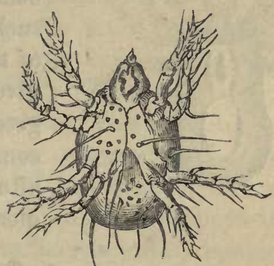


Fig. 8.



The form described as the third (fig. 8) exhibits a constant difference in the form of the body and bristles, which are slightly crooked and uniformly plumose on both sides. The first joint of the legs is very long. The animal appears to me closely to resemble the cheese-mite. Some kind of strayed mite is certainly referred to.

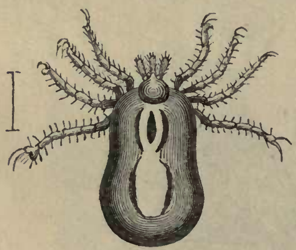
Family of the Ticks = Ixodida.

Acarida magna, plana, in dorso cephalothoracis testa cornea obtecta, abdomine, si vacuum est, plicato, si sanguine repletum est valde intumido. Testa respiratoria parvula, orbicularis; punctum respiratorium punctiforme, parvulum, rotundum. Pedes breves, pariter articulati, ad imaginem "patris nostri" formati, in apice unguiculati et arolio, qui stylo caret, armati; rostellum maximum, prominens; palpi vaginæformes, ad rostellum applicati; labium protractum, semicanellatum (like a half-canal) *denticulatum; mandibulæ breves, crassæ, ex* 3 *articulis compositæ, in extremo articulo acutæ et denticulatæ. Oculi parvuli. Habitant in silvis et in fructicetis aridis ad gramina, muscos, &c., siccos, unde ad*

cutem hominum, aut animalium prætereuntium et adeo ad cutem serpentum, testudinum, &c., transeunt.

1. *Ixodes Ricinus,* the common Wood-Tick = the Dog's Tick, and also perhaps the Egyptian Tick (fig. 9.)

Fig. 9.



Martiny describes it as oval, yellowish blood-red, thorax darker, abdomen finely hairy, with the lateral walls bent upwards. The females, which are only 1''' in length, become of the size of a hazel-nut by sucking. A good figure of the parts of the mouth of the Egyptian tick is given in Pöppig's 'Illustrirter Naturgeschichte,' iv, p. 53, fig. 2845. The common tick is here represented after Gurlt. The line at the side indicates the natural size.

2. *Ixodes marginatus* = the Margined Tick.

According to Martiny, longish, obovate, flat, brown, shining, with separate short hairs. Female 1''', becoming as large as a pea by suction.

3. North and South American Ticks = *Ixodes Americanus, I. humanus, I. crenatus.*

They occur in the woods of these countries, frequently in extraordinary quantities, and almost epidemically, and possess various local names,—for example, wood-louse = *Pou de Bois* in Pennsylvania, *Niyua* in Carthagena, *Pique* in Peru, and *Carabatos* in Brazil, in all parts of which, according to Martiny, they are a great plague to men and animals. The particular species are but imperfectly known and distinguished.

All the species are particularly attached to dry, sunny woods, thickets, or hills, and avail themselves of every opportunity of getting upon animals. Imperceptibly they immerse their proboscis in the skin, often in very sensitive spots, and often remain for days hanging to the place where they have bitten in, held fast by the retroverted teeth of the surfaces and margins of the pro-

boscis, during which, by unceasing sucking, their flat form becomes globular, and ten to twenty times its original size. If they be torn away with violence, the head easily remains sticking, by which inflammation, pain, and suppuration, lasting even for months, are produced; for this reason it is always advisable to compel them to loosen themselves.

Therapeutics.—The only indication is to cause the voluntary detachment of the animal. For this purpose Oken advised the dropping of a drop of olive oil upon them. But they do not always let go their hold after this. Ratzeburg recommends rubbing the animal constantly with the oiled finger, for which a quarter to half an hour is often required. In his 'Illustrated Natural History,' Pöppig recommends touching them with tobacco oil, oil of turpentine, or mercurial ointment. The last is superfluous. The oils just mentioned are certainly sufficient, or still better the essential oils, such as oil of anise or rosemary. I would, however, not merely touch the back of the animal, but rather in preference rub its ventral surface with a feather dipped in the oil, so as to come as near as possible to the respiratory opening on the belly, and poison the animal as quickly as possible.

The tick often mentioned as the *Argas Persicus*, or the poison-bug of Miana, may also be referred to here. As what has been narrated of it and its dangerous nature is mere fable, and the natives take it into their hands quietly and without danger, I shall only treat of it here *en passant*. Its bite, like that of all *Ixodida*, probably causes considerable pain, and if the head be torn off and left sticking in the wound, it may also produce malignant sores. But everything is fable. The bad consequences commonly ascribed to it, agree with the symptoms of the putrid fevers which prevail in hot climates, often endemically in small districts, and carry off more especially foreigners who have not become acclimatised, whence it is probable the opinion has arisen that the mite only injures foreigners.

The *Argades* are distinguished from *Ixodes* by their having a small head, seated on the under side of the fore part of the body, a very short proboscis, and three-jointed, conical palpi. The *Argas Persicus*, which only occurs in Persia, is characterised by the small, white points which extend over the whole back, and are the more striking upon its light blood-red colour, because it is usually larger than the wood-tick (namely 3‴), and has the anterior legs directed forwards as raptorial arms.

Family of the GAMASIDA = Beetle-lice.

Corpus oblongum, depressum, interdum clypeiforme; pedes longitudine varii, articulis inter se æqualibus, in apice libero 2 *unguiculis et præterea arolio armati; palpi liberi, filiformes, pariter articulati; organa manducatoria variantia, mandibulæ acres, ad terebrandum idoneæ, non uncinatæ* (vide Ixoda). *Animalia cœca, in avibus, insectis et reptilibus parasita, plerumque nocturna et inter diem prope ad stabula, receptacula et latebras animalium majorum viventia. In prima juventute sex, in statu larvarum* (*Hypopus veterum*) *vero* 8 *pedibus, quoram posteriores minimi et aroliis armati sunt, instructa et mobilia.*

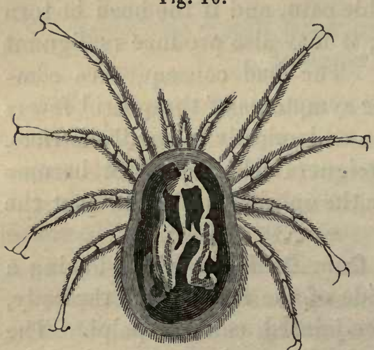
Sub-familia—DERMANYSSUS.

Palporum articulus 5 *minimus; rostellum acutum; mandibulæ feminarum gladiformes, marium forficiformes, unguicula longissima; corpus molle; pedes anteriores longissimi; coxæ continuæ; larvæ* 6 *pedibus instructæ.*

Dermanyssus Avium (fig. 10).

Oval, broader behind, flat, brownish red, by two lateral cœca; thorax with a white V-shaped spot, and behind this two pale waves, a transverse spot and two points. Length about 0·30‴.

Fig. 10.



It lives especially in dovecotes, fowl-houses, and on the perches and canes of bird-cages and aviaries, where it also lays its eggs, and undergoes its changes of skin, only attacking the birds and sucking their blood at night.

Alt saw these mites upon the neck and arms of an old cachectic woman. They are white, of the size of a grain of sand, extremely agile, and slipped out of little excavations (which even occupied a space of 1½ square line), ran over the skin, and back again into their holes.

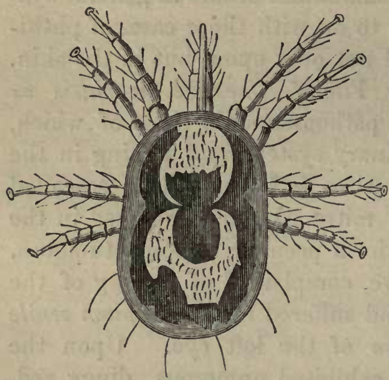
Kirby and Spence, and Alt, denominate the disease produced thereby *acariasis*, and think, as it sometimes occurs in general dyscrasic and adynamic tabes, it has to do with those cases of phthiriasis, in which the parasites lived not only upon, but in the skin.

To the latter form probably Fuchs' *Cnesmus acariasis* = *Milben-Hautschabe*, amongst the pathognomonic signs of which, besides derangements in the urinary system and itching in the skin, is the existence of the parasites *in* the skin (the so-called *Phthiriasis interna*). Fuchs saw mites like lice produced in the tissue of the uninjured skin, and form peculiar bursting tumours. The patient, who was consumptive, complained of itching of the skin and urinary disturbances, and suffered from *ectropium senile* of both eyes, as well as *hypopyon* of the left eye. Upon the skin of the neck and back she exhibited numerous, dingy red, very painful boils, on scratching which small mites, like lice, crept forth from them in thousands, together with a clear, putrescent fluid. We do not know, however, whether these animals came out of the cutis, or the subcutaneous cellular tissue, nor has this species of mite been hitherto exactly determined. According to all experience it cannot be transferred to healthy subjects; just as Bourguignon asserts, for instance, that the mites of animals usually attack only sickly individuals of the animals preferred by them. According to Fuchs, a case of Laval's and one of Kurtze's may also belong to this form. The patient always died in the last stage of consumption.

Bory's case must also probably be referred to this place. A little while before the death of a dropsical woman, it was observed that with an improvement, itching also constantly occurred, and this gradually became stronger, and finally insupportable. Whenever the woman scratched herself, thousands of little, brownish animals came forth and crept into the linen; so that when it was very warm, she was obliged to change her linen from three to six times a day, on account of the immense number of animals which crept forth.

To the section of *Dermanyssus Avium* Martiny also refers Erdl's mite in the pimples of the human skin, and regards it as the male of Alt's mite, from which it is only distinguished by a longer proboscis, even projecting beyond the palpi (fig. 11). Whether in Erdl's case we have to do with the true mite of our domestic birds is uncertain. Simon narrates a case in which the mite nestled upon the skin of a woman who was otherwise healthy.

Fig. 11.



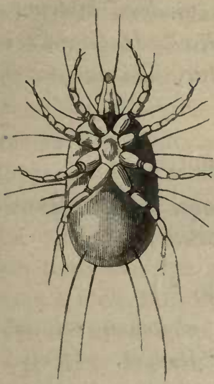
She was constantly infested with little louse-like animals, notwithstanding great cleanliness and many attempts at the extermination of the mites, which were recognised by Erichson as *Dermanyssus Avium*. It was found at last that the woman went several times daily into the cellar, over which the hen-roost lay. As often as this was the case the fowls flew up into their roosting-place, and by this means the woman was sprinkled with mites. The removal of the hen-roost cured her of her supposed phthiriasis. It would perhaps be advisable to refer this species of mite to the *Acarus nidulans*, of which we find examples amongst sky-larks and small birds, or perhaps to arrange it with those species of mites which we certainly sometimes meet with in the hair-follicles, and on the inner wall of the skins of mice in small nests, and which I have repeatedly found on the animals of my colony of mice. This mite has also been found on the skin of the horse (the 'Veterinarian,' Morton and Simonds, 1855, p. 443.)

A mite has also been found by Busk *in the matter of peculiar large sores on the sole of the foot of a negro.*[1] The somewhat mystical account of the case tells us that the negro had worn the shoes of another negro from Sierra Leone, and that, according to Stanger, similar animals occur in a river (it must have been a species of *Hydrachna*), and according to Murray a peculiar prurigo, which is difficult to cure, occurs in Sierra Leone, which is perhaps connected with this mite. As the whole story is suspicious, we can say but little upon this mite. According to some it is a *Dermanyssus*. On the other hand there are also species of *Sarcoptes* on animals (dogs and horses), which have a liking for pus, and if there be any truth in the story it might be a *Sarcoptes*. Willan has also described a small parasite in *prurigo senilis*; it was found in great numbers upon the skin and in the linen of a patient, and was regarded as a flea, and very indistinctly represented. At last it has been thought that these

[1] Appendix A.

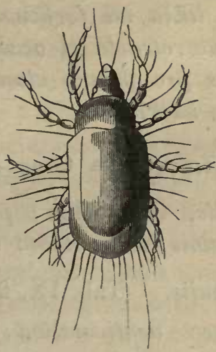
parasites are to be regarded as body-lice (perhaps young individuals). This animal also belongs to the doubtful ones. The

Fig. 12.



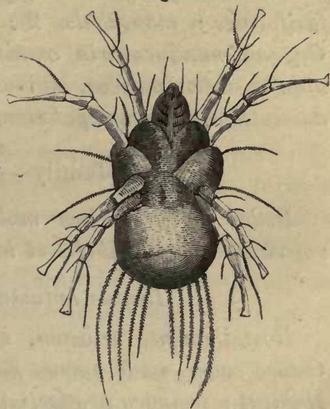
Cheese-mite, from beneath.

Fig. 13.



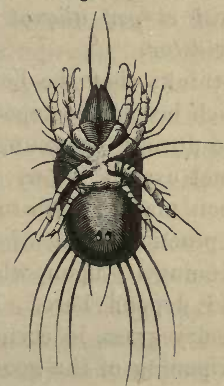
Cheese-mite, from above.

Fig. 14.



Mite from dried plums.

Fig. 15.



Raisin-mite.

Fig. 16.

cheese-mites also, as well as those from dried fruits, raisins, &c., may produce a transitory irritation upon the skin, but no disease (*e. g.*, pustules, and other exanthemata; Raspail). Nyander's intestinal itch (*scabies intestinorum epidemica*) and his *Acarus dysenteriæ* certainly belong to mites which already occurred in the night-chairs, &c., and which we meet with in old vessels and in decaying places (Martiny), or to the mites of raisins or dried fruits, such as Reinhardt, of Bautzen, found in the vomited matter from a woman who suffered from cancer of the stomach and *ulcus perforans ventriculi*.

Family of the Grass- and Plant-mites = ORIBATIDA (Vogt) = LEPTUS (Latreille).

Animalia durissima, quasi vitrea; plerumque sulco transverso quasi bipartita; secundum par pedum anteriorum in corporis dimi-

dium posterius retractum ; abdomen etiam testâ, in cujus 2 lacunis porus genitalis et porus ani aperiuntur, obtectum. Pedes breves validi, unguiculati, pileati, in juventute 6 ; *palpi breves et fusiformes ; mandibulæ* 2 ; *labia ad forficum modum instructa. Organa manducatoria omnino retracta et occulta. Habitant : in nidulis inter muscos, quibus pro pabulo utuntur, nisi sanguinem animalium, tanquam pabulum hauriunt.*

Sub-family—Leptus = Grass-mites.

Pedes 6 (?) ; *corpus molle, intumidum ; palpi magni, liberi ; rostellum ex mandibulis et labiis compositum ; oculi* 2.

Leptus autumnalis. (Tab. IX, fig. 8.)

Rostellum nec setosum, nec denticulatum ; abdomen setosum. Colore ruber, unde nomen Scabiei inde exortæ "Rouget. Oculi 2. *Habitat : tempore præsertim autumnali in frumentorum stipulis ac herbis, in arborum (ex. c. Ribes grossulariæ) foliis et baccis, unde transit ad manus et corpus non obtectum hominis (ex. c. messoris), quas perforat et per aliquot tempus incolit. Hieme inter muscos habitare videtur.*

Von Siebold thinks that the hexapod mite is only the young state of one which becomes octopod after changing its skin, and which is parasitic during its young state, the mature condition of which we do not exactly know. One of the first observers of its wandering upon man appears to have been Janson ; the best statement, in a practical point of view, has recently been given by Jahn, of Meningen, upon whose published and epistolary communications I depend here. In the autumn the mites in question keep in dry grass, in corn which is ready to cut, and at the time of the ripening of the gooseberries, upon the gooseberry bushes. Thence they get upon the skin of men, who brush past their places of abode. Thus, for example, they settle in masses upon the stockings of women and children, when they have visited the gooseberry garden early in the morning, and bore into the human skin only with the head, in the same way as the *Ixodes*. They there form yellowish-red points in the skin, and may be easily detected by the practised eye, as Professor Emmerich observed in his own children. By their immigration they produce little swellings, papulæ, impetiginous pustules, or flat and innocuous sores, upon and in which the yellowish-red parasite sits in the form of a small point of the size of a pin's

head. Emmerich never found passages, and their position was generally at such a small depth, that with a little practice they could easily be removed with the finger-nail or a needle, and if then put upon paper ran about briskly. Sometimes, also, the animals are seen arranged in the form of a wreath or necklace, or in masses and troops. The time of their parasitic existence does not last long. This mite is usually found upon man only in July and the beginning of August; subsequently it probably goes into the moss on the ground, to pass through its further development there in quiet. For this reason Jahn was unable to send me specimens of these parasites in September. But I am none the less grateful to him and Emmerich for the kindness with which they furnished me with information upon this parasite, which I have hitherto sought for in vain in this place.

During harvest the mite bores, often in immense numbers, into the skin of the reapers, and, indeed, in the neighbourhood of the roots of the hairs, producing troublesome itching, inflammation, swelling, and even fever. On account of the red colour of the mite, the complaint has been denominated "Rouget."

According to Jahn and Emmerich, the mite which I have figured upon Plate IX, fig. 8, agrees with that observed by them; except that the eyes are wanting, as the drawing, for which I am indebted to the kindness of Professor Leuckart, represents the mite from the ventral surface. However, there is a figure of the mite in Wiegmann.

According to Jahn and Emmerich, the mite rarely lives very long as a parasite upon the human skin; even a few days' residence is a rarity. But when peculiarly unfavorable external circumstances are in action, and the patients are constantly passing by those places where the mite is abundant, as, for instance, the gooseberry gardens, the disorder may last for several weeks and months, by the chain of consecutive relapses, but never over the time of harvest.

Diagnosis.—The discovery of the mite upon the body is rendered easy by the colour of the animal. It can then be taken out of the centre of the swelling with the point of a needle. To collect them from the gooseberry bushes, it is only necessary to lay a sheet of white paper under the bushes upon which the animal is common, and then beat the bushes.

Therapeutics.—The avoidance of the places infested by the mites is sufficient; according to Jahn, washing with soap and water,

or a solution of liver of sulphur, and I think washing with essential oils, as well as the picking off of the individual red points, as the animals are not yet capable of propagation.

A similar mite, called "*Bête rouge*" in Martinique, according to Kirby, wounds the soldiers standing in the fields in that island, and produces such bad sores that even amputations of the limbs have been obliged to be undertaken; or, under the popular name of "doctor," pesters the woodcutters and colonists on the Mosquito Coast and in Honduras Bay.[1]

Fourth Class of the Articulata.

Insecta = The Insects.

Articulata antennata, organis respiratoriis perclaris, corporis regionibus bene distinctis, abdomine sine appendicibus, pedibus 6, *plerumque alata.*

The body consists of separate segments, some of which are sometimes entirely or partially amalgamated. However, the head, thorax, and abdomen are generally clearly distinguishable. The thorax and abdomen are coalescent only in a few apterous parasites.

1. The *head* bears the antennæ and oral organs, as well as the eyes; the three thoracic segments bear the three pairs of feet on their lower surface, and the wings on their upper; the very distinctly articulated abdomen never bears feet, but at the utmost accessory organs of motion, and always the sexual apparatus. The *antennæ*, placed on the front of the head, on the forehead, or on the sides, have very different forms, which, however, may be referred to the form of a bristle, or that of a ringed or jointed club or cone. The external surface of the uniform antennæ is, with the exception of the basal joints, beset with small pits and pores, the bottom of which is closed with a delicate, downy skin. The unhomogeneous antennæ have a separate stem or shaft, exactly resembling the skin of the body, and the above-mentioned pores and pits, which probably have the function of feeling, and perhaps also that of smell, exist only upon the teeth, laminæ, &c. The differences of the antennæ serve for the definition of the groups and species. The sense of touch is also assisted by the eyes, which are very rarely wanting. The *eyes* are, partly simple *ocelli* (or *stemmata*) which usually stand in aggregations or groups upon peculiar

[1] See Appendix A.

elevations on the sides of the head, and have a beaker-shaped retina, surrounded by dark pigment, a roundish lens, and a convex prominent cornea; and partly *compound reticulated eyes* (*oculi*), that is to say, prominent (roundish, reniform, or deeply notched) projections on the two sides of the head, which in the males sometimes even meet upon the vertex, sometimes sit upon immoveable stalks, and possess an immense number (often many thousands) of facets of equal size, each of which forms, as it were, the cornea of a minute eye. We also find a pyramidal lens, with an obtuse apex directed towards the beaker-shaped vitreous body, an optic nerve dilated like a horn, and a dark pigment, as to the co-operation of which in the formation of an image we can form no idea. In some insects we find *both simple and compound eyes*. Then two or three ocelli are seated above upon the vertex, and so near to the cephalic ganglion that their optic nerves only form short warts. The function of the ocelli is unknown; but they do not appear to be organs of distant sight, as some will have it, as their cornea and lens are always very convex.

The oral organs follow a single fundamental type of structure, and are sometimes adapted for suction and sometimes for biting. The manducatory organs consist of—1, a median *upper lip* (*labrum* = Oberlippe = Lefze); 2 of two lateral, generally hook-shaped, horny *mandibles* (*mandibulæ* = Oberkiefern = Kinnbacken); 3, of two other lateral jaws (*maxillæ* = Unterkiefern = Kinnaladen) placed beneath these, usually furnished with jointed appendages, the so-called *maxillary palpi* (= *palpi maxillares*); 4, of a *lower lip* (*labium* = Lippe) placed quite beneath, which is also provided with palpi, the so-called *labial palpi* (= *palpi labiales* = Lippentastern), and like the labrum is capable of moving up and down. The upper lip, which is rarely immoveable, generally moveably articulated to the lower surface of the head, covers the mandibles from above. The mandibles consist of two hollow, horny pieces, which are attached by a hinge on each side of the head, and can only move in opposition to each other. The less solid nourishment the animal takes, the more insignificant do the mandibles become, and at last they are entirely wanting in the suctorial insects. The maxillæ are very composite, weaker and less toothed than the mandibles; they approach very close to the labium, or are even coalescent with it, and consist of a shaft or stalk (*stipes*), which is composed of a transverse *angle* (*cardo*), and the true stalk (*stipes*), which is often hook-like, hard, and

frequently beset with acute horny teeth, with the lobes (*malæ*) on the inside, and maxillary palpi (*palpi maxillares*) on the outside; the latter are rarely wanting, usually shorter than the antennæ, longer than the labial palpi, and in the number of joints strictly fixed in every order of insects.

The maxillæ, which are usually clothed with hair internally, grasp the food firmly. In the sucking insects they are converted into piercing bristles, or into sheathing valves, or into spirally rolled semi-canals, which form a tube by their contact.

The *labium* with its palpi usually sits upon the *chin* (*mentum*), that is to say, a separate plate on which there is a valvular articulation; it is indented or notched in the middle, or even divided into two parts, hairy, rarely smooth; it closes the oral aperture, and contains a soft membranous process, the *tongue*, sometimes with independent processes, the *paraglossæ*. The labium and tongue sometimes form an open proboscidiform sheath, sometimes a beak or rostrum, sometimes a sucking proboscis, and sometimes a scooping proboscis. The retrogression of one of these parts in comparison to the others produces a great variety in their structure.

2. The *chest* = *thorax*, which is usually the largest of the three divisions of the body, bears three segments—the *prothorax* or fore-chest, the *mesothorax* or middle-chest, and the *metathorax* or hinder-chest—which are more or less mutually coalescent. Each of these segments consists of a *sternum* (or breast-bone), that is, the lower surface of the chest, and a *dorsal surface*. If the prothorax be much developed it is called the *corselet* (*thorax* = Halsschild); it never bears wings, but only the first pair of legs. The mesothorax is most developed where the anterior wings are the most important organs of flight, in other cases it is even reduced to a *scutellum* (or little shield) upon the upper surface. The metathorax is most developed where the posterior legs are adapted for leaping, or the posterior wings are the most essential. The *wings* are deficient in most of the human parasites, for which reason I pass over their structure.

The *legs* consist of—1, a hip or *coxa*, which, with a cylindrical or elongated head and femoral appendage (= *trochanter*), moves in the manner of our humerus, by an imperfect ball and socket joint, or a sort of rolling, in the socket of the segment; 2, of the *thigh* (= *femur*), articulated by an imperfect ball and socket joint into the coxa, and is cylindrical, spined, and very thick in the hind legs

of leaping insects; 3, of the thin, long *tibia*, united with the thigh by a hinge-joint; and, 4, the *foot* = *tarsus*, which is rarely eight-jointed, usually composed of five joints, with the joints dilated, beset with balls, brushes, or warts on the lower surface, and with the last joint furnished with two, or rarely with one, curved, sharp, horny claw, which is very seldom deficient. The legs are adapted for digging, leaping, swimming, seizing prey, walking, or running.

3. The *abdomen* exhibits a still more distinct annulation than the head and chest. The rings consist of an upper and lower arch, which are united at the sides and above and below, and between the scaly layers of the segments, by elastic skin. The normal number of abdominal segments appears to be nine; but this is often unrecognisable by the sliding of the last segments into each other. They have no legs, but in some the immoveable bristles serve as leaping organs.

The *skin* is of various degrees of hardness, consists of chitine, which is so difficult to destroy chemically, and often perfectly homogeneous and structureless, but frequently deposited in strata, furnished with bristles, hairs, &c., attached more or less firmly on the outside, and internally with processes for the attachment of the muscles.

The *muscles* are transversely striated, like the voluntary muscles of the higher animals, but in the duration and efficacy of their action accomplish much more than could be expected from their mass.

The *nervous system* consists of a series of ganglia, which is united by two longitudinal filaments, and always lies upon the lower integument. In the head there is a brain with the antennal and optic nerves, which gives off two filaments downwards to form an œsophageal ring; from this pass off longitudinal filaments, which are sometimes separated, sometimes more coalescent, in accordance with the structure of the segments themselves. Besides the ventral cord there is a separate intestinal nervous system (two nerves forming a pair and a median one) for the œsophagus and stomach.

The *sense of touch* is abundantly provided for by the antennæ, the palpi, the apex of the proboscis, the female ovipositors, and the tarsi. The organ of *taste* is unknown, as are also the organs of *hearing*, with the exception of the ears of the *Orthoptera*.

The *alimentary canal* is always intestiniform, of very various

lengths, and composed of several coats; longer in herbivorous than in carnivorous species, without a peritoneum, and only held in its place by the ramifications of the air-passages. We find a mouth, a muscular œsophagus, on which is a pharynx which is usually folded and furnished with racemose or tubular salivary glands, then a round gizzard with horny ridges, bristles, and teeth; and, in sucking insects, also a sucking stomach hanging by a stalk near the œsophagus. Upon the gizzard follows the very large lobate, folded chylific stomach, which is beset, to a greater or less extent, with short glandules (villi), and into the hinder end of which the kidneys open; these are urinary vessels, either cæcal, or passing into each other to form loops, and containing yellowish or reddish urine, which embrace the intestine. The intestine presents a narrow ileus, and a cloaciform large intestine, clothed internally with transparent ridges of glands, and sometimes with a cæcum and a muscular rectum. The anus is situated in the last segment, sometimes with anal glands with stinking or poison contents, which also occur at the articulations of the legs (*Meloë*), or on the lower surface of the chest (bugs). Connected with the alimentation are the fat-glands, which are retrograde in the mature insect.

The *circulatory system* exhibits a tubular *heart* or *dorsal vessel*, composed of several—usually eight—chambers, furnished with (sixteen) lateral openings and valves, which acts as a syringe, and a main artery, passing through the thorax and head, and terminating freely in one or several openings, from which the colourless blood, containing only a few colourless corpuscles, is distributed through wall-less canals in various directions through the body.

The respiratory organ is a system of ramified *tracheæ*, or air-tubes, running in all directions through the body, even into the feet, &c., which communicate with the outer world by peculiar openings, *spiracles* or *stigmata*, placed in pairs on the sides of the body, often differently coloured, surrounded by peculiar horny rings, and capable of opening and closing by the agency of horny rings. They carry the air to the freely circulating blood. They form membranous, double-walled, multifariously branched tubes, which are kept open by a spiral horny filament laid between them, and which is only wanting in the smallest ramifications; in flying insects they are often dilated into air-sacs (without spiral filaments). These tracheæ either present two large wide stems on each side of the ventral cord, into which the stigmata open and

from which the branches issue, or the air-tubes pass at once from each stigma to the organs, but even here also form lateral communications.

Reproductive organs.—In all insects sexual reproduction takes place, with the exception of the nurse-formation occurring in summer in the *Aphides*. The *females,* the sexual organs of which are sometimes abortive (the so-called neuters), have two ovaries, short oviducts, and a vagina with peculiar appendages, namely, the copulative pouch, which receives the seminal filaments from the penis of the male during copulation, the seminal receptacles, which often constitute two large spiral tubes, into which the seminal filaments afterwards wander, and in which they remain for months, the cement-organ, that is to say, glands immediately in front of the sexual aperture, which furnish the external shell of the egg.

The *males* have two tubular or racemose testes, two seminal ducts, often furnished with lateral seminal vesicles, and which coalesce to form one seminal duct, with the reception of two glandular tubes. The seminal filaments are usually capillary, sometimes inclosed in firm sacs (spermatophora). Copulation is often the principal purpose of these animals. The entrance of the vagina is frequently beset with horny bands, and other horny appendages which we denominate the *ovipositor;* when it is denticulated externally, and intended for boring, it is called the *saw,* in a simple and finely pointed form the *terebra,* and when it stands in connection with a poison-gland, the *sting.*

The males are generally smaller, brighter in colour, and furnished with various excrescences, sucking discs, &c. The care of the eggs is entirely left to the females, and sometimes extends so far, that the latter assist the brood in their pupation and exclusion.

The eggs, which are of very various forms, but usually oval or cylindrical, often have different appendages, and are also cemented together; a granular yelk, germinal vesicle, and germ-spot are wanting in the mature eggs. The *development in the egg* takes place in accordance with the type described under the Articulata.

1. The creature excluded from the egg is but rarely similar to its parents in form, &c.; it generally becomes like its parents only in consequence of several changes of skin, after the last of which only it propagates. The envelopes usually burst in the neigh-

bourhood of the neck. These insects are called *Ametabola,* i. e., *insects without a metamorphosis*—for example, the lice.

2. In a second case, we certainly find the external form pretty like that of the parents, but the young animals are still destitute of some organs of the adult, especially the wings. These semi-larvæ, as they are called, only become similar to their parents by moulting. The state in which only immoveable wing-sheaths and no moveable wings are presented, has been sometimes called the *pupa.* It is essential that these semi-larvæ as pupæ always eat and move about. These are the *Insecta hemimetabola,* or those *with an imperfect metamorphosis*—for example, the bugs.

3. In the third case the young, on their exclusion from the egg, are quite unlike their parents, and undergo a complete metamorphosis through three different, well-defined conditions.

a. Larvæ, which eat, grow, and usually change their skins several times. They have the form of jointed worms; are footless, or furnished with six legs, and sometimes also with false feet; are very soft, sometimes smooth, sometimes with hairs, spines, horns, or lateral appendages, which assist in walking, or as tufts of bristles in swimming. The head is sometimes soft, sometimes horny, and bears the oral organs, which are frequently much reduced. Manducatory organs are always present, sucking organs only in the headless larvæ of flies and some Hymenoptera, which are parasitic in the larva state. In herbivorous larvæ the jaws are broad and toothed within; in carnivorous larvæ they are hook-shaped, and often perforated to their apex, so that the nourishment is taken up by this instead of the mouth, which is deficient; the upper lip (*labrum*) is usually wanting; the maxillæ are usually present, but only conical and without lobes. The lower lip (*labium*) is greatly developed in those which spin themselves up, and bears the opening of the silk-glands. The antennæ are retrograde or entirely wanting; the palpi usually small, conical, and two-jointed. The eyes are few and *simple,* never *compound,* and sometimes entirely deficient.

The intestinal canal is always large and wide, especially in herbivorous species, filling the entire cavity of the body; the chyle-stomach is especially large; the ileus small. The species which spin a cocoon have two long tubes (silk-glands), with a sticky secretion which immediately hardens into threads in the air. Every cocoon consists only of a single thread. The dorsal vessel is greatly developed; the individual ganglia of the ventral cord

much separated. The sexual organs are quite rudimentary, only the inner germigenous organs being recognisable. In aquatic larvæ, we find breathing tubes in the abdomen or externally closed tracheal branchiæ. Towards the end of its larval existence, the insect prepares for its conversion into—

b. The *pupa;* it eats no more, evacuates its intestines, seeks a favorable place for pupation, spins itself an envelope, digs itself a hole, or conceals itself in putrefying matters, remains still for a time in the larva skin, and causes this to harden; or this integument bursts, and the hard pupa comes forth. The form of the pupa, which often allows the future animal to glimmer through it, is very various; for example, the cask-like pupæ of the *Diptera.* Finally, the pupa-case is burst, and the animal comes to light as—

c. The *perfect insect* (= *imago*) to take nourishment again, and propagate its species. These animals are called insects with a complete metamorphosis = *Holometabola;* for example, the *Pulicida,* or fleas, *Œstrida,* or gad-flies, and *Calypteræ*=*Creophilæ,* or flesh-flies.

The intellectual qualities of some insects stand so high, that we can hardly speak of them as instinct alone. The account of the development just given, like all the other general observations upon insects, from Vogt, furnishes the facts for their classification.

First Sub-Class—Insects without a metamorphosis = Ametabola.

First and only Order—Aptera = Wingless Insects.

Corpus rarissime tripartitum, plerumque abdomine et thorace coalito. Caput liberum, antennis brevibus, setosis. Stemmata pluria ad utrumque capitis latus, oculi veri nulli; organa manducatoria rudimentaria, suctoria aut manducatoria, maxillis acribus, mandibulis dentatis, sæpissime sine palpis labialibus et maxillaribus; pedes aut breves, validi et unguiculati (cursorial feet), *aut graciles, longi, tenues, mobiles. Medulla abdominalis generis; canalis intestinalis brevis, præterea generis; vasa urinaria* 4 *ad* 6. *Trachearum* 2 *trunci laterales. Genitalia feminarum: ovaria pluria, ex* 4 *aut* 5 *tubis composita; oviductus brevis: sine loculis copulatoriis*

et apparatibus ovula pariendi peculiaribus. Mares 2 aut pluribus testiculorum paribus; pene simplice.

Ovula rotunda, interdum in capsulas longas invaginata. Embryones parentibus similes.

Of Vogt's four groups—1, *Pediculida*; 2, *Nirmida*; 3, *Podurida*; and 4, *Lepismida*—only the first interests us, and if *Trichodectes* should be transferred to man, also the second.

First Family—Lice = Pediculida.

Corpus planum, pellucidum; cutis mollis, semipellucida, corio similis; caput perclare distinctum, triangulare, globuliforme, aut ovale; antennæ breves, filiformes, ex 5 *articulis æqualibus compositæ, parum setosæ; stemmata mimina pone antennas; rostellum plane retractile, in vagina molli, infra dilatata, in apice uncinulata,* 4 *setas punctorias, pugionem formantes, continente inclusum. Thorax parvulus, non clare articulatus, foramine* 1 *respiratorio in utroque latere inter* 1, *et* 2, *par pedum; pedibus* 6, *brevibus, validis anterioribus* 2 *interdum minoribus, ex brevi, crassa coxa cum parvulo trochantere, ex magno, plano femore, ex parva tibia et ex tarso inarticulato cum talo parvulo prominente et uncino magno compositis; abdomen magnum a thorace bene distinctum, præter in Phthiriis; articulorum segmentis in margine perclaris* 7 *ad* 9; *superficie papillosa, aut acinulata (striis irregularibus instructa), setosa; stigmatibus respiratoriis abdominalibus in utroque latere* 6. *Genera sejuncta.*

From the structure of the eggs Leuckart reckons the lice to the *Hemiptera*, which I will not omit to mention here. As, however, I have commenced with Vogt's classification, I have referred them to the *Aptera*.

The Common Louse = *Pediculus capitis*. (Tab. IX, figs. 9—12.)

Synon.: *Pediculus humanus, cervicalis.*

In this species the thorax is pretty distinct, elongate quadrangular, narrower than the abdomen; the abdomen exhibits seven segments notched at the margins; the stigmata, which stand upon the six anterior segments, are circular, and furnished with a small opening in the middle. The stigma between the first and second pairs of feet is often indistinct and resembles a small papilla. The colour varies, livid or pale gray, and is said to

change according to the hair; all the segments are blackish on the margins. In the human louse I have always found the same transverse ridges on the inner surface of the belly, which are seen in *Trichodectes.* All the feet are similar. The last tarsal joint bears a large claw on its outside, and on its inside two straight, thick, horny stumps, and a large bristle. The œsophagus is short; the longish stomach has two cæcal appendages. The small intestine is only slightly bent into the form of an S, receives four urinary vessels at its extremity and passes over into the pyriform large intestine. The most essential points as regards the sexual relations are as follows:

The males are fewer in number than the females, their last abdominal segment is prominent and rounded off, furnished on its dorsal surface with a valvular opening beset with an abundance of asperities, which serves at the same time as an anal opening and *porus genitalis.* There are two pairs of testes and a simple wedge-shaped penis, which, placed with its base inwards and its apex outwards, opens upon the back. This organ is described by certain authors, as a strong muscular member; to me it appears to form a hollow chitinous canal, the lateral walls of which are stiffened and coloured brown by a strong deposition of the chitine-mass, whilst the bottom of the channel is formed of thinner, whiter chitine. The seminal structures are as usual, for example such as are figured for the Trematoda, but I have never with certainty found active, isolated filaments in the testes, but more commonly the stellate bundles.

The females, which are more numerous and larger, appear deeply notched at the apex of the last abdominal segment and, as it were, with two lobes, between which is the anal aperture, which is surrounded by numerous hairs. The two ovaries consist of five tubes each, collecting into two oviducts and a common vagina, into which two seminal receptacles open. The vaginal orifice is situated on the ventral surface, between the penultimate and last segments. Its lower surface forms a transverse ridge, which is extended in an arched form across the body, and is beset with small digitate asperities, arranged in four to six parallel rows, and their vicinity with small, horny, warty eminences. Hence copulation can only take place, by the female mounting upon the male.

The eggs of the common head-louse, according to R. Leuckart, are pyriform and very large, about $\frac{1}{4}'''$. The posterior pole is pointed,

the anterior truncate and furnished with a flat, round operculum, which, at the margin, passes over into the side walls almost at a right angle, and is let into the rest of the chorion by a furrow which only cuts through its outer strata. The chorion, with which the delicate vitelline membrane appears to be firmly amalgamated, is very firm and $\frac{1}{500}'''$ in thickness, homogeneous and structureless, except the operculum, which presents an uneven, finely granular surface, Swammerdamm's *little knobs without any particular form*, to the number of 10—14. These little knobs are cells with delicate membranes, closely approximated, and which are displaced by the mere pressure of the covering glass and then form a folded mass ; they are about $\frac{1}{45}'''$ in diameter and have the margin of the operculum free. Even Swammerdamm was acquainted with a *white point* in the midst of these knobs, which he described as a *small hole*. This little hole is the micropyle, a perpendicular canal of $\frac{1}{1200}'''$, which is somewhat dilated externally, and furnished at its margin with a circlet of projecting tubercles, by which the external aspect of the micropyle is rendered stellate. Further from this aperture we also perceive a distinct annular ridge of about $\frac{1}{180}'''$ in diameter. The posterior pole of the egg is truncated, striated by longitudinal folds and ridge-like deposits, and appears to form an adhesive apparatus.

When the eggs are laid, they stick firmly to the human hair, and are called *nits ;* in six days they allow the young to escape, and these are ready to lay eggs again at the age of eighteen days. A female lays fifty eggs in all.

The *diagnosis* is easy, because the lice creep about upon the head, and their eggs are large enough to betray themselves to the naked eye, especially in dark hair.

The *symptoms* which they produce are a troublesome itching upon the skin of the head, which alone they inhabit. Wounding by lice betrays itself by an eruption, on the apex of which there is a blood-red crust, which is produced by scratching off the epidermis, which is loosened over a considerable space by reactive phenomena and by the subsequent emission and drying of a few drops of blood.

Therapeutics.—When the hair is otherwise healthy and not too long and thick, careful combing is generally sufficient ; with care this will effect the object in about eight days, as the brood escapes in six days and only begins to lay eggs in eighteen days. But if the hair be very thick, and at the same time long or

much matted, as is the case especially in tedious illnesses with women who wear long hair, we shall attain our object but slowly, if we do not cut out the hairs beset with nits, or cut off all the hair, as the animals easily escape the comb. The rubbing in of mercurial ointment appears to me unadvisable, as we have milder remedies of more rapid action. The essential oils are worthy of recommendation, as may be seen in the fact, that those who employ strongly scented pomatums to the hair are less exposed to lice and other vermin. But if the lice are present in great numbers, the cure with the essential oils is often slow. In this case it is most advisable, especially when the patients are lying in bed, to sprinkle the scalp with the Persian insect-powder (*Pyrethrum caucaseum*) which is now generally kept in the apothecaries' shops. In a few hours after this the itching ceases, because the lice are killed, and sleep, which was often sought in vain by opiates, returns to the unfortunate patient. I remember the case of a consumptive patient of good condition who was near death, and on whom I certainly had no idea of finding lice. They were developed in very great numbers from the heat of the bed. There was a desire to regard them as *Pediculi tabescentium;* but it soon appeared, on closer examination, that the servant who was most engaged about the patient, and who was much infested by lice, was the cause of their production, and the *Pediculi tabescentium* (from which it appears that people in good circumstances would rather suffer than from the common *Pediculus capitis*) were ordinary head-lice. Oils employed for several days certainly diminished the number of the lice; but the insect-powder soon killed them.

The common people formerly made use of the Capuchin powder and similar remedies against lice. The Capuchin powder consists of equal parts *Semin. Staphisagr., Sem. Cocculi, Semin. Cataputii* (whence, probably, the name). Since an attempt at poisoning was made with the internal administration of this powder it has been forbidden in Saxony, and as Capuchin powder is still constantly required, the apothecaries, instead of it, give any mixture which they consider to be a remedy for lice. In many of these the *Pyrethr. caucas.* has a part. Amongst us the species of *Pyrethrum*, even our indigenous species, are gradually becoming used for this purpose.

Besides the head-lice here named, a particular species has been found, according to Pouchet, on African negroes. This I am

unacquainted with; but, according to the figure given by Martiny, it is of a black colour. I have omitted it until we have more exact investigations of it. Lice are rare, according to Martius, amongst the Brazilian Indians, and, according to Justin Goudot, amongst the Indians of Madalena, in Columbia; but, according to the reports of travellers, lice do occur amongst the Asiatic and American Indians, as well as amongst the New Hollanders. We shall probably find these animals often in great quantities amongst those people who wear long hair and do not anoint it with scented or stinking oils. In the nits of the hairs of New Zealanders of the present day, as also in those of the Peruvian mummies, I have found the dried brood of lice, which, after treatment with a solution of caustic potash, showed the six stigmata on each side of the abdomen quite distinctly. I am indebted for the materials for this investigation to Herr Stieglitz, who is at present traversing Germany with his cabinet of Peruvian mummies, which are pronounced to be genuine by connoisseurs. The New Zealand head which, in order to interest the less educated public, is exhibited as that of the murderer of Cook, is rich in nits, and so is the head of a Peruvian. For the purpose of comparison I give the following measurements of the claws of the different nits.

	Claws of the nits of European lice.	*Claws of those of New Zealand.*	*Claws of those from Peru.*
Length.........	0·114 mill. = 0·050‴ P.	0·172 mill. = 0·075‴ P.	0·148 mill. = 0·065‴ P.
Breadth at base	0·025 „ = 0·011 „	0·033 „ = 0·014 „	0·025 „ = 0·011 „
Length of nit to operculum	0·860 „ = 0·390 „	1·012 „ = 0·450 „	1·150 „ = 0·510 „

From this it appears that, with regard to the size of the eggs and claws, considerable differences certainly exist, which, perhaps, may justify the admission of varieties.

Phthiriasis.—Aristotle narrates that the poet Alcmanes and the Syrian Pherecydes died of phthiriasis; and later authors report the same of Herod, Sylla, even Plato, Philip II, and others. This phthiriasis, as we have seen, relates to an excessive multiplication of mites, *Dermanyssi, Nirmida,* and common or body-lice. For the present I join with those who suppose that a peculiar species, *Pediculus tabescentium,* does not exist.

2. The Body-Louse = *Pediculus vestimenti.* (Tab. IX, fig. 13.)

Synon.: *Pediculus humani corporis, humanus.* Kleiderlaus, Germ.

Exactly like the preceding in its external form, but larger. Head exserted, elongated oval; second joint of the antennæ elongated, the antennæ therefore are longer than in 1; thorax distinctly divided into segments; legs longer, more slender, and with larger claws; on the inside of the last tarsal joint two horny stumps and a bristle, as in the common louse. Abdomen with seven segments, and with six stigmata on the first six segments. Penis as in 1, but considerably larger, and the asperities about the genital orifice more striking. Orifice of the vagina with rows of spines, as in the preceding species. Length $\frac{3}{4}'''$—$2'''$. Colour dirty white, blacker on the margins. The principal distinction between the body-louse and the head-louse lies in the size; for even the proboscis only has the hooks at its free extremity larger than in the head-louse.

Symptoms.—According to Schinzinger this animal produces its mischief especially on those parts of the skin which correspond with the folds and seams of the clothing, about the throat, neck, and round the body where the petticoat or waist-band lie close. In these seams the animals lay their eggs, and consequently become most flourishing with those who cannot frequently change their linen. They only occur upon naked parts of the body, and day and night produce a constant biting and itching on the skin, which leads to continual rubbing and scratching. The external phenomena caused by them resemble those of the preceding species; the skin becomes quite red, exhibits the scabs described, papulæ, and even vesicular eruptions where the skin is very tender.

The treatment is the same as with the preceding, but the cure is even still easier. A bath, and afterwards putting on new clothes from head to foot, or even old ones which have been disinfected in an oven as described for the itch-mites, suffices for a cure. To purify the clothes, the common people bury them in hay for several weeks. As a boy, I have had the opportunity of observing this method in the country. The lice certainly did not return when the clothes remained for fourteen days in the hay; in this time even the embryos in the nits die or become abortive. Moreover, it is said that a journey towards the tropics expels these lice, and that they do not occur in hot countries.

Second Family—Crab-Louse = Phthirius.

Corporis regiones ad unam fere massam globulosam coalitæ, thorace vix distinguendo, brevi, lato; abdomine lato et in marginum utroque latere cum 8 segmentorum incisionibus; antennis longioribus; pedibus inæqualibus, anterioribus 2 sine talo et uncino in talum mobili (pedes ambulatorii), posterioribus 4 ut in pediculis, cum talo et uncino in talum mobili (scansorial feet).

1. The common Crab-Louse = *Phthirius pubis.*

Synon.: *Pediculus pubis, inguinalis;* Morpion.

It has a fiddle-shaped head, with a prominent, rounded forehead and a broader proboscidal aperture than the common louse, and a somewhat projecting vertex with waved (buchtig) sides in the neighbourhood of the antennæ; a rather short, dilated, and rounded occiput; very small, somewhat prominent eyes, immediately behind the filiform antennæ, which are slightly hairy, five-jointed, and gradually diminish in size, with the fourth joint rather smaller than the third and fifth; with a very broad and flat thorax, emarginate at the insertion of the head, with three pairs of feet and a stigma between each of the first and second pairs of feet; and with a flat, cordate abdomen, amalgamated with the thorax. If we go according to the stigmata, we find first an apparently simple anterior segment which bears three stigmata; we must, therefore, certainly suppose that this segment consists of three which have become fused together. It is separated from the following segments by the lateral, verruciform lobe, which diminishes in a conical form towards its free extremity, where it is clothed with hair, and exhibits six bristles. This lobe, which has some similarity with a rudimentary foot, is followed by three similar ones, each of which bears a stigma and which becomes longer posteriorly. The second stump bears six bristles at its free extremity, the third six to eight, and the fourth always eight to ten. This last lobe is followed by the terminal segment, which is notched in the female in the same way as in the common louse. It bears five larger bristles on the hindmost free apices, and also towards the median line a pair of very short stumps, and also on the dorsal surface six longer bristles. Here are placed the vagina and the anus. In the male the hinder part is rounded. On her ventral surface the female

bears thick, brown, irregularly disposed stumps, and on her dorsal surface smaller ones more sparingly distributed. The unequal, elongated legs are walking feet in front, gradually narrowing to the cylindrical, unemarginate tibiæ, which have a small tooth, and on the tarsus attached to them a small, nearly straight claw. But behind they are thick, powerful scansorial feet, the tibiæ of which are large, bell-shaped, indented at the extremity, and somewhat in front upon the inside have a large tooth, furnished with a small, straight, chitinous stump and a bristle; the tarsus is long, crooked, one-jointed, horny, and bears a large horny claw, which turns back upon the tooth of the tibia like a pair of nippers. This claw is always very massive, but rather blunt than acute anteriorly and towards the free extremity. It is seen distinctly that its inner margins are toothed and that it is hollow interiorly. To the interior of its base there pass two short, strong muscles, which give the tarsal joint the appearance as if it bore a bell (without a clapper) in its interior.

The reproductive organs are not quite clear to me, as I have only been able to examine females. Leuckart says of the eggs that they are considerably smaller than those of the common louse; but, in other respects, exactly similar to them, except that the annular ridge, which surrounds the infundibular entrance into the micropylar canal, is very much wider than in the common louse ($\frac{1}{10}'''$ in diameter), and the operculum presents a wide lattice work, formed by radiating processes.

The crab-louse lives on the hairy regions of the body, especially about the pubis, but when it increases excessively, also amongst the hairs of the chest, the eyebrows, the eyelashes,[1] but never in the head. It bites deeply and firmly into the skin, producing violent itching, and lives on the human blood. It is transferred to other individuals by long contact, and by the agency of clothes, linen, and beds. It is most abundant in the south.

Schultz, with certain classes of people, regard the lice as beneficial to the animal economy; carriers cherish them in order to put one under the prepuce of their horses when they cannot make water.

Therapeutics.—As the crab-lice are endemic in certain districts, we must be particularly careful there. The treatment is the same as with the other lice. I have cured a patient who had long

[1] In Dalrymple's 'Pathology of the Human Eye,' London, 1852, is a drawing (Pl. VI, fig. 6) of an eyelid with groups of these lice upon it.

been troubled with these guests, by two rubbings with a few drops of rosemary oil. According to Martiny rubbing with simple oil or fat is sufficient. The essential oils are certainly more sure in their action. The insect-powder is also used against them with advantage.[1]

Second Sub-Class—Insects with an incomplete metamorphosis = HEMIMETABOLA.

Order—RHYNGOTA = HEMIPTERA.

Corporis tres regiones bene distinctæ; caput parvum, latum, triangulare, tenue; labium (lower lip), *transverse articulatum in rostri vaginam mutatum, quæ canalem cavam, et ad anteriorem partem apertam exhibet;* 4 *setæ tenues* (*pugionem formantes*) *in rostri vagina inclusæ, musculis fusiformibus motæ, quarum* 2 *exteriores, validiores, in apice uncinatæ mandibulas, quarum* 2 *interiores firmius inter se conjunctæ maxillas præbent. Labrum* (upper lip) *in initio rostri vaginæ situm, operculum tenue est, ad linguæ instar formatum. Palpi maxillares et labiales desunt. Antennæ filiformes, diversissimæ. Stemmata parvula, rotunda, prominentia; oculi adjutorii nulli. Alæ variæ, rarissime mullæ, uti in Acanthia lectularia* (the bed-bug). *Thorax perclaro scuto, interdum scutello.*

Pedes ambulatorii tribus tarsi articulis; interdum pedibus anterioribus ad raptum, pedibus posterioribus ad natandum idoneis.

Ganglia thoracica 2, *interdum in unum coalita. Œsophagus augustus, ventriculus chyli amplus, multifariam, tortus, cujus anterior pars glandulosa, media intestino similis et posterior torta est. Intestinum breve, pyriforme. Glandulæ salivales perclaræ, sine dubio venenum parantes, tantum in Ophididis nullæ. Canales urinarii* 4. *Tracheæ variæ.*

Ovaria plerumque 4—8 *tubi rudiformes; loculus seminalis simplex, longus, pyriformis; loculus copulatorius nullus; vix organa ferrumen* (cement-organ) *parantia.*

Testiculi ex numero varii, culeiformes; ductus deferentes longissimi; penis simplex tubulosus.

Ovula larvas, parentibus similes, usque non alatas tenerrime plumosas, vernatione pluries exuta, alarum vaginis aut alis ornatas, parientia.

Pro nutrimento succis et plantarum et animalium utuntur. Animalia plerumque socialia.

[1] The mercurial ointment is a well-known and efficient remedy in this country.—TRANS.

Family 5—Geoceres. Land-Bugs.

Corpus latum, planum, parvum; antennæ filiformes aut setosæ, liberæ, cylindrice articulatæ; capite longiores. Rostrum in capitis apice incipiens, geniculatum, usque ad finem thoracis profectum. Alæ 4 variæ; pedes ambulatorii æquales, spinosi. Odore fœtido, coloribus sæpissime perpulchris instructa. Sub-familiæ permultæ.

Sub-Family 3—Acanthida = Soft Bugs.

Rostrum three-jointed; tarsi without arolia.

Body soft; head and body flat, horizontal, longish; eyes small, without ocelli; rostrum short, concealed beneath the throat; antennæ short, clavate, of half the length of the body (not reaching beyond the breast); wings membranous and veined, or wanting; prothorax, abdomen, and wing-cases with membranous processes; legs weak, thin; the anterior sometimes raptorial.

1. The common Bed-Bug (*Acanthia lectularia*).

Body ferruginous brown, somewhat hairy; head distinctly separated; thorax of one joint, with a tubercular pronotum, and one pair of feet; on the back with two small tubercles (the rudimentary wings); number of ventral segments nine, which run out in a point behind.

Upon the eggs, Leuckart speaks as follows: "They are elongated ($\frac{1}{2}'''$), cylindrical, and of nearly uniform breadth ($\frac{1}{8}'''$), rounded off at the hinder extremity, bent forwards in the direction of the dorsal surface, and furnished with a flat operculum, which is surrounded at the margin with an annular screen, and is incorrectly ascribed by Meissner to the inferior pole of the egg. Chorion firm, structureless, and smooth;" whilst De Geer and Dufour describe it as covered with points. Tubercles only make their appearance upon and round the margin of the operculum; but these, as in the family of the *Reduvinæ*, stand on the inner surface of the egg-membrane. This inner surface is adapted for the reception of air, in the same way as in the *Reduvinæ*, by thin, perpendicular, separate canals. The surface of the operculum is covered by a delicate lattice-work, the ridges of which circumscribe tolerably regular spaces ($\frac{1}{60}'''$), and are most developed

towards the centre. The micropyles, 100 in number, and distant from each other $\frac{1}{450}'''$, form extremely narrow canals ($\frac{1}{2000}'''$), which pass inwards from the screen, open then, and exhibit a longitudinal ridge of $\frac{1}{1500}'''$ on the inner surface of the screen. Externally these micropylar openings form clefts, which occur upon the anterior clavate extremity.

Even in the eleventh century, bugs were naturalised in Strasburg, so that they did not come to us from America. Very plentiful in the north of Russia, they are not found in South America, New Holland, and Polynesia. They are so difficult to extirpate because they can bear hunger for years, and also a great degree of cold. They live on the blood of man, and attack him particularly at night, after leaving the joints of the woodwork and walls, the crevices in the paper, and the grooves in the bedsteads, in which they lay their eggs everywhere; they also harbour in clothes.

The wounds produced by their bite are distinguished by the size of the resulting spots, and by their troublesome itching. In their centre, also, we may detect a pierced canal, by the aid of the lens. It is certainly possible that in doubtful cases the diagnosis may be rendered more certain by the smell, and by the examination of blood-spots in the bed-linen, from which we might probably be able to evolve the characteristic odour of bugs by solution in water and treating with acids, but we get at the bottom of the affair still better by the examination of the bedsteads, &c.

Treatment.—An immense number of tinctures and secret remedies are sold against bugs, of which, according to Pöppig, no single one will prove efficacious, although a combination of several may do so. In this case, also, I have seen very good results from the Persian insect-powder, the price of which is now greatly reduced. It is sprinkled in the joints of the woodwork and walls, the bedsteads, mattresses, &c. It is as well, however, in places where the bugs are very plentiful, to repeat the sprinkling of the powder from time to time, and at all events regularly at the beginning of spring and the approach of autumn, or shortly before the winter torpidity and at the time of waking therefrom, as in such places the larvæ in the eggs may perhaps escape the action of the powder. Care should also be taken, that the brood should be sought out and destroyed wherever they can be got at in their hiding-places.

Third Sub-Class—Insects with a complete metamorphosis = HOLOMETABOLA.

Order—DIPTERA = Two-winged Flies.

Corporis 3 regiones bene distinctæ, rarissime fere cephalothorax (Pulicida). *Cutis mollis, expansibilis.*

Antennæ frontales, inter oculos positæ, aut corpore breviores, triarticulatæ, tertio articulo latiore, foveoso, et brevi, interdum articulato, stylo (= bristle), *aut corpore longiores* (*ex sex et ultra articulis compositæ*). *Oculi magni, imprimis in maribus, quare in fronte coaliti, et inter singulas lentes setosi aut stemmata. Interdum stemmata auxiliatoria 3, aut 2, rarissime nulla.*

Organa manducatoria suctoria. Labium mutatum in proboscidem, trompe geniculatum, retractilem, in apice latiorem, rotundam, aut ovalem, sulcis transversis et setis instructam. Os in genu proboscidis situm, palpis 2, ex 1—2 *aut* 4—5 *articulis compositis et sæpe antennæformibus. Maxillæ ex 2 setis chitinosis, cum palpis conjunctis, et mandibulæ ex aliis 2 setis, ex maxillarum forma compositæ formant haustellum. Labrum in fundo proboscidis, triangulare, antrorsum acutum, chitinosum aut membranaceum, in inferiore latere canellatum, linguam brevem, tenuissimam continens, et interdum in setam, uti maxillæ et mandibulæ, allongatum. Hypostoma* (=lower face) *est spatium inter proboscidem et oculos*; *mystax* (= moustache) *sunt buccæ setosæ in hypostomate prominentes.*

Thorax rarissime articulatus, unicam massam chitinosam 3 lineis aut sulcis transversis ornatam exhibens, 4 stigmatibus respiratoriis (2 *anterioribus,* 2 *postertoribus*).

Alæ aut 2 pellucidæ, membranaceæ, rarissime squamosæ, magnæ, longæ, versicolores, aut, rarissime vero, minus evolutæ aut omnino nullæ. Costæ, quas dicunt, aut nervi alarum longitudinales 5, *transversæ numero minores.*

Halteres (= balancers) *sunt 2 corpuscula mobilia, stylosa, et capitulo ornata in posteriore thoracis parte, vibrantia, squamarum membranacearum* (alulets) 2 *paribus obtecta.*

Pedes longi, tenues. Tarsus constat usque ex 5 *articulis, quorum ultimus 2 ungues simplices aut dentatos et inter ungues arolia* (foot-balls = *pelottes*) 2 *ad* 3, *foveosa aut callosa gerit, et fluidum glutinosa secernit.*

Abdomen tenue, longum, interdum latum aut ovale, clarius sejunctum a thorace, aut non ; ex 6—9 *articulis compositum, in feminis acute finitum, denuo articulatum ei ex telescopii ratione pro- et retractile.*

Nervorum abdominalium systema in Nemoceris 5 *ad* 6, *in Brachyceris* 1 *ad* 6, *in Muscidis, Pupiparis et Œstridis nulla ganglia abdominalia ; nervorum thoracicorum systema* 1—3 *ganglia simplicibus filis inter se conjuncta exhibens. Organa digestiva simplicia ; œsophagus cum ingluvie et ventriculo, cui ventriculus suctorius stylosus aut vesiculosus adhæret, intestinum tenue et rectum, latum. Hepar et glandulæ salivales simplices, tubulosæ. Systema vasculosum tenuissimum ; trachearum* 2 *trunci cum stigmatibus cohærentes et* 2 *vesiculas aëreas in capite et abdomine præbentes.*

Feminæ habent 2 *ovaria, ex numerosis tubulis formata ; oviductus breves ; loculos seminales plures, plerumque* 3, *vaginam sine appendice seminali ; interdum larviparæ aut fœtus usque ad tempus, ubi in nymphas sese transformarunt, gerentes.*

Mares præbent 2 *testiculos, pyriformes, funiculos spermaticos parvos, penem brevem, a* 2 *valvulis lateralibus, vaginæformibus, inclusum.*

Larvæ sine pedibus ; capite aut membranaceo, aut corneo ; cute, quæ in pupæ cystam mutatur.

Sub-Order—Aphaniptera = Hopping Diptera.

First and only Family—The Fleas = Pulicida.

Caput perparvum, pronatum, stemmatibus lateralibus ; antennis 2, *brevibus, claviformibus, cylindricis, ex* 4, *secundum Vogt ex tribus articulis compositis, plerumque in canellam pone oculos retractis ; proboscide, oris locum tenente, directo sub capite posita, et composita ex labro* (i. e., *vagina bivalvulare et articulata, cum palpis* 5 *articulatis*), *ex lingua inter labra sita et ex* 2 *maxillis lateralibus. Palpi* 2 *maxillares. Pedes longissimi ; femur crassum ; pedes posteriores saltatorii. Thorax triarticulatus. Pedes unguiculati ; abdomen articulatum. Ovula inter materias vegetabiles putridas deposita larvas vermiformes, sine pedibus, capite corneo armatas et inter saliendum ex annuli ratione sese curvantes pariunt, quæ post* 12 *dies capsulas sericatas* (silken cocoons) *nent, unde post novas* 12 *dies imagines prodeunt. Stigmata respiratoria* 4 (2 *in Prothorace ;* 2 *inter Meso- et Metathoracem*).

1. The common Flea = *Pulex irritans* sive *vulgaris*.

The head of this reddish-brown animal which is so widely diffused over the earth, but unknown in Australia, is short, shield-shaped, formed of one piece, not toothed on the margins; the antennæ are short, and concealed in a pit behind the eyes, and therefore often overlooked and mistaken. The oral organs consist of a bristle-like tongue, which is covered by two maxillæ of the form of two sword-blades. These maxillæ are covered by two very narrow mandibles, which lie together to form a sheath, and are toothed on their convex upper surface, like files. On the sides of the proboscis, and somewhat covering the base of the four-jointed antenna, are two massive brown scales; these are usually called labial palpi, and probably form a sort of cleft upper lip. The labium covers the proboscis from beneath, and like the upper lip appears to be cleft. It is hollow above, acute and hairy in front.

The thorax, which is probably provided with two pairs of stigmata, consists of three separate segments, each of which, especially the third, bears a pair of long legs, well adapted for leaping. These consist of a strong coxa, with a small trochanter, a strong thigh and tibia, which are all but slightly hairy internally, and of five tarsal joints. The first and longest of these is strongly clothed with hairs internally, without hairs on the outside; the other smaller joints are strongly hairy on both sides, and the last bears two claws. The first pair of feet appears almost to stand on the head.

The abdomen has ten laterally separated segments, laid over each other like the tiles of a roof, and fringed at the margins. On the penultimate, or ninth segment, called the *pygidium*, there are spinous hairs inserted in little pits (*areolæ*). Each of these areolæ is about 0·012 mill. in breadth, and adorned round the base of the hair with a circle of ten round, bead-like globules.

Besides its small size, the male is distinguished by the form of the extremity of his abdomen. The upper end of the *pygidium*, namely, projects as a sharp angle, and the last joint is attached scarcely perceptibly flat to this. By this the end of the abdomen of the male becomes as if cut off straight and broader. At the same time it appears to me that the pygidium is rather less hairy than in the female, and that the penis is double. At least we always see two brown spiral fibres in the middle of two more membranous, transparent structures, which are swollen up into

the form of a club and clothed with radiating bristles towards the outside, so that these ends have the appearance of an old German "morning star" (*morgenstern*). On the abdomen the male has also two roundish valves or clasping organs.

The female is larger, and has the last segment of its abdomen obtusely conical, and either pointed or rounded off; this is so amalgamated with the pygidium, that we can scarcely find in it the projecting angle indicated. The hairs are more numerous, and reach up to the dorsal surface. On the abdomen it has a verruciform, fringed lobe.

The copulation takes place belly to belly. The oval white eggs are pretty large ($\frac{1}{3}'''$), barrel-shaped, broad, but slightly arched, and uniformly flattened at both poles. The vitelline membrane is as usual, the chorion strong, thick, uneven, scaly, and beset with innumerable, small, flat, approximated pits.

Leuckart shows that the simple micropyle is wanting in these eggs, and they are consequently distinguished from the Diptera; he states that the micropyles are found in a number of cribriform apertures, upon a round field of $\frac{1}{50}'''$, at both poles of the egg. The upper apertures are larger than the lower ones, and somewhat more numerous (50—60 above, 40—45 below). In these the seminal filaments are found. In profile the micropyles appear as perpendicular canals, leading straight through the chorion and vitelline membrane, and dilated in form of a funnel externally. The eggs are deposited in sweepings, dust, and, in dirty people, under the nails, especially the toe-nails; in two days they allow the escape of apodal larvæ, which bear small tufts of hair upon the segments, and two small hooks upon the last segment; they move very briskly, afterwards become reddish, and have a head which is scaly above, with two short antennæ, but without eyes. The pupa is developed in a small shell.[1]

Vogt states that only the females bite and suck the blood of men. The anatomical structure of the head, and especially of the proboscis, does not justify this supposition, which I, for my own part, cannot confirm. One day, on my return from my patients, whilst writing, I felt a pretty sharp bite on the right thigh, and simultaneously another, but weaker one, on the upper arm. As I was desirous of making a couple of microscopic preparations of the oral organs of the flea, I undressed myself, and captured a female flea on the thigh and a male on the arm. I had felt pain

[1] The 'Veterinarian,' London, 1855, p. 335.

in both places, and looked after the fleas just at the corresponding spots. The female had an abundance of blood and blood-corpuscles in her; the male had a reddish fluid, as to the presence of blood-corpuscles in which I was not quite certain. At any rate, the males can extract a bloody serum from the body.

Some species of fleas of our mammalia also occur temporarily upon man; for example, that of the dog, &c. These I pass over, however, although they constitute distinct species.

2. The Sand-Flea = *Pulex penetrans.*

Synon.: *Dermatophilus, Sarcopsylla penetrans,* Chique, Chigue, Pigue, Funga, Punque, Chigger, Gigger, Tschike, Tungúa, Attun, Ton, Nigua, Tunga, Xique, Bicko.

It is smaller than the common flea, and has a proboscis as long as the body, whilst in the common flea this is at the utmost one sixth or one fourth of this length. The valves at the extremity of the male, which only lives in the sand, and does not attack man, are much elongated; the impregnated female swells up extraordinarily, after it has burrowed under the skin of men and animals. The head, thorax, and feet are only recognised as attached points. According to the statements of most authors, the animal only lives as far as 29° of south latitude in the hot countries of South America, especially in Brazil; whilst Goudot found it even in the cold region of New Granada, as far as Bogota. According to the journals of Count Görtz, besides sand, this flea likes to dwell in the crevices and joints of pig-styes. Some people suppose that there are two species. Neither the male nor the unfecundated female has yet been seen in the skin of man or the domestic animals. According to A. von Humboldt, it only attacks Europeans and not the aborigines; Martius says that it is attracted by the sweat of the negroes.

Martiny gives the following notes upon it from Dobritzhofer. This animal is so small that it can only be seen by sharp eyes, with a good light, for which reason the seeking for the flea after its immigration is generally left to children. It perforates the skin down to the flesh, and, concealed in its little canal, swells up into a white, globular vesicle, which in a few days may become as large as a pea, the pain constantly increasing; this is the abdomen of the female filled with eggs, or, more correctly, with larvæ. Neglect of the disorder, or careless rupture of the vesicle,

that is, the abdomen, by which the young are scattered in the wound, where they then mine fresh passages, leads to bad sores, to inflammations of the glands of the groin, to mortification, and, in consequence, to amputation or mutilation of the limbs, or even to death. The toes are especially attacked by the flea, although other parts of the body are also visited.

Treatment.—Prophylaxis : Persons who are staying in places where the flea is endemic, must have their feet examined by children every two or three days. I think it would be advisable for residents or travellers in those districts to pour a few drops of an essential oil (for example, oil of anise or rosemary) now and then into their stockings or shoes, in order to keep off the insects by this odour.

Active treatment.—When the animal has once made an entrance, the orifice of the canal, which is marked by a red point, may be sought, the passage widened with a needle, and the flea drawn out, but without tearing it. With fresh punctures it is best to wait a day, until the occurrence of the white vesicle, that is to say, the swelling of the abdomen with the brood, allows the animal to be more readily detected. Here also I should think that touching this vesicle with oil of anise would be beneficial and kill the flea (because the respiratory stigmata are situated upon the abdomen), or compel it to wander out. The cavity remaining after extraction is treated like a simple wound. In Brazil they fill it with oil, snuff, or ashes.[1]

Sub-Order—Brachycera = True Flies.

Corpus latum, rarissime longum; caput hemisphæricum aut ovale, thorace latitudine par; abdomen amplius; proboscis aut brevis, crassa, carnosa, retractils, aut longa, prominens, coriacea. Antennæ in canellam capitis retractiles ad ultimum ex 3 *articulis, quorum* 2 *parvi et stylosi sunt, tertius vero crassus et globulosus stylum* (bristle) *aut palpum habet, compositæ. Alæ rarissime desunt.*

Family of Bot-Flies = Œstridea.

Corpus setosum; proboscis nulla aut minima; palpi haud clari; antennæ brevissimæ in sulco capitis reconditæ, tertio articulo globoso

[1] See Appendix B.

et in dorso setoso; squamæ halterum permagnæ; alæ in quiete ab abdomine distantes.

In this division only the eggs and larvæ are of interest to us, and indeed at present only in as far as they belong to species which live upon the skin, and there form boils. Nothing certain is known of the occurrence of the larvæ of *Œstri* in the frontal cavities (*cephenemyia; cephalemyia*), unless the worm of Fulvius Angelinus, referred to under *Linguatula*, was such a larva, which on closer examination always appears more and more improbable to me, even on account of the size of the larva (which is said to have been as long as the middle finger). I here commence with two cases which appear to me to be as yet the most certainly proved in Europe.

In the 'Ephemer. natur. curios.,' Dec. I, Ann. 2, p. 43, Schulze gives the following narration, under the title, "*Vermium in vivorum corporibus generatio singularis in oculorum palpebris et aurium cavitatibus.*"—Caspar Wendlandt, in Poland, extracted a white worm from the eyelid of a peasant boy of two years old; it was of the size of a caterpillar, with a hardish skin. Around the eye of the patient there was a considerable red swelling; the eyelids were closed, and the pain violent. But after the extraction of the worm, neither matter nor blood flowed out of the opening in which it made its appearance. (I pass over the appended fable of the worm's eating almonds.) Dr. Leonhardt, of Mühlhausen, also saw a worble in the umbilical region of a man. Unfortunately this case is not sufficiently proved. If I am not mistaken, a further case is reported incidentally in Iceland by Torstenson. Unfortunately I cannot find the quotation relating to it.

In the south of America this parasite is by no means rare upon man. It occurs especially upon the arms, the back, the abdomen, and the scrotum. A. von Humboldt gave it the name of *Œestrus humanus*. In Guadaloupe and Cayenne the larva is named *Ver macaque*, in Trinidad *Ver maringouin*,[1] in Minas Geraës *Beme*, in New Granada *Gusano del monte*, and in Peru *Flug lacura*.

As soon as these animals have become so far developed that they are about to change into pupæ, they emigrate, let themselves drop upon the earth, and then pass through their next two stages.

The surgeon will certainly seek in vain for fluctuation in the

[1] Father Guby, 'Supp. Act. Erud.,' tom. i, p. 425, in his 'Report on his Travels,' describes probably this insect.

tumours produced by them, but will find an orifice in the swelling from which a little moisture constantly oozes, and through which the hinder part of the *Œstrus* is kept in communication with the air. The *prognosis* is favorable; immediate cure is only possible by incision and the removal of the *Œstrus*.

It has not yet been settled to what species of *Œstrus* these larvæ belong, and it has even been supposed, as, for instance, Humboldt has done, that there is an *Œstrus humanus*. We are not at present justified in the latter course. The insect brought by Schomburgk as the parent of this larva, was a *Tabanus* (a gad-fly), and can by no means be connected with the larva. The common people also still make the mistake of confounding bot-flies and gad-flies. As the matter stands at present, we can only assert that in the last-mentioned cases the *Œstrus Ovis* cannot come in question, nor the species living in the frontal cavities of the stag. Neither can we have anything to do with the horse bot-fly (*Œstrus equi*). The species which come under consideration here are the *Œstrus Bovis, Cervi Capreoli,* and *Cervi* which live under the skin.

We have here to observe, that the female *Œstrus* has a horny ovipositor, which slides out and in like a telescope, and bears five teeth at the end. On the one hand it has been asserted that this ovipositor is used as a boring apparatus in burying the eggs at the moment of laying; on the other, that it has not sufficient strength for this purpose. Those who hold the latter opinion think that the eggs are stuck upon the hairs, and that only the larvæ bore under the skin.

The bot of the ox is black, reddish-yellow in front, clothed with black hairs behind, and becomes an inch long in two months. The bot of the stag is distinguished from the preceding by a series of recurved black hooklets, which, in conjunction with the larger horny hooks at the mouth, enable the larva to hold fast in the tumour. Of the larva of *Œstrus Cervi Capreoli,* the last figure has recently been given by Hennig, of Dresden. Reichenbach, sen., names the *Œstrus pictus* as its parent. The larva itself is yellowish-white, 10″ long, and has nine segments, exclusive of the head and tail, like all larvæ of *Œstrus*; of these, the first seven are beset on the back with rows of very fine reddish-brown spines (in ten rows), which, however, only extend to the fourth segment on the ventral surface. The mouth has two very small, blackish-brown, horny hooks; the dorsal surface

has a brown spot, consisting of nothing but points. On the flattened part of the tail, we see two very small, broadly oval, oblique, dark reddish-brown opercula, much smaller than in *Œstrus Ovis*; these close the two main tracheæ from without. The surface of the opercula is veined and finely punctured. Beneath the opercula is the opening of the intestine, which, like the alimentary canal and stomach, is situated, as in the other *Œstri*, in the centre between the tracheæ. The eggs of particular species of *Œstrus* have opercula.

Sheep, cattle, and horses are only infected in thickets and woods, where the female *Œstri* sit, and attack the passing animals. This is not to be overlooked in the etiology and prophylaxis.

Family of the Flies = Muscida.

From the enormous number of genera (200) we must be contented with having the characters of the *Brachycera* before us, and to state the distinctions of the particular genera. For us particular interest attaches to the flower-flies = *Anthomycida*, and the flesh-flies = *Calyptera* or *Creophila*.

1. *Anthomycida* = Flower-Flies.

Squamæ sive ailerons (= alulets) *halteribus multo minores. Antennæ retro repositæ tertio articulo oblongo. Oculi fere frontales, in maribus propinquiores. Corpus longum. Caput hemisphæricum. Larvæ 2 unguicules ad os armatæ, in vegetabilibus putrescentibus viventes, sine pedibus.*

We know that larvæ of *Anthomyia scalaris* and *canicularis* have been met with in the human intestine. They may be recognised by their maggot-like form, by the plumose lateral and dorsal spines, and the two separated, stalked breathing tubes on the last segment of the body. The spinous bristles on the back and sides are said to produce a very unpleasant itching in the human rectum. I advise surgeons, in order to obtain specimens of this larva, so as to be able to know what they are about in case of need, to look after the larvæ in the intestines of dogs, where they occur by no means rarely in autumn and winter. Upon the literature of this subject consult Von Siebold, article

"Parasiten," in Rudolf Wagner's 'Handwörterbuch der Physiologie,' ii, p. 683, note 1, and 684, note 2. It appears only to be possible for these animals to reach the human intestine indirectly, and indeed by the use of vegetables which have stood for some time, and to which the female *Anthomyiæ* could have access. As vegetables of this kind, Von Siebold particularly refers to cabbages; I think any farinaceous food which has been kept and which is eaten cold is sufficient for the purpose. The eggs of *Anthom.* (*Hyalemyia*) *canicularis* measure $\frac{1}{3}'''$, and are uniformly rounded at both poles. The dorsal surface is even covered with two parallel folds bent inwards, which suddenly cease at the end with an obtuse angle. The ventral surface with hexagonal facets and punctures. The inner surface of the dorsal folds and of the back exhibits broad, rafter-like elevations, by which the facets are rendered smaller; it is also punctured. The micropyle is situated upon a large smooth space at the anterior pole without any distinctive mark (mouth-piece, points, or the like). In the true *Anthomyiæ* the pores have become real pits, and the transverse ridges between the facets are tubercular. The micropyle is funnel-shaped. The larva probably escapes at the anterior pole, on which a blunt process is sometimes found.

2. *Creophila* = Flesh-Flies.

Corpus compactum, abdomen rotundum, thorax latus, caput transversum squamæ (= alulets) *halteribus majores. Nonnullæ viviparæ. In juventute* (*statu larvali*) *parasita.*

a. The great Bluebottle = *Musca vomitoria* = *M. erythrocephala* (Aut. recent).

Leuckart describes the eggs of this fly as follows: Eggs tolerably compressed, 1''' long, uniformly truncated at both ends; upon the very flat dorsal surface a white stripe (a peculiar apparatus of longitudinal ridges, a duplicature of the chorion) extending from one pole to the other, or even a little beyond the superior pole. The delicate, pale, limpid vitelline membrane, which folds readily, may be easily separated from the brittle chorion, which is beset with delicate, hexagonal facets, $\frac{1}{70}'''$ in diameter, with small, close points, which are rather pits or pores than elevations. The little points may be very distinctly recognised as pits

at the posterior pole of the egg. The chorion and vitelline membrane adhere to each other quite firmly at particular places, more especially about the true micropyle, so that the openings pass through both membranes. The micropyle of the bluebottle flies gives us the clearest insight into the penetration of the seminal filaments into the egg, and it is particularly to be recommended for the study of this process. It occurs at the superior pole of the egg, which is rendered as uneven as the rest of the chorion by facets and pores, and in its centre. The albuminous mass of the egg covers the micropyle and the superior pole. The eggs are usually laid in this state, but sometimes the larva has already become completely developed in the egg, so that it is frequently excluded whilst being examined under the microscope, whence arises the supposition that the eggs are hatched in two hours. The larva bears two blackish-brown points at the extremity of its abdomen, and has a very complicated oral extremity; its margin is divided in a radiate form, and it has six spiracles on the abdomen. In eight days it attains its normal size without changing its skin, and becomes converted into a cask-shaped pupa by mere thickening of the skin; from this the fly escapes in a few days. The fertility of this fly is so great, that Reaumur counted 20,000 maggots in an oviduct $2\frac{1}{2}''$ long. The larvæ of this fly cause the so-called "living wounds" to which Pruner, for example, refers. They especially prefer the orbits and ears, but also every part of the body where there is the least abrasion or discharge. To the naked eye such places appear as if beset with headless nails, which rise and fall with the extension and contraction of the animals whilst sucking. Pruner thinks that in such wounds we have to do with the larvæ of *Sarcophaga carnaria*; I have arranged them here on account of the black points on the abdomen. In ulceration, and when their position is superficial, we distinctly see the white body of the larva, which is $2'''$ in thickness; the head sits, with its hooklets, in the bottom of the wound, which usually secretes no pus, but only a bloody, watery fluid, and has a bluish, pale, and after the removal of the animals a favus-like, spongy appearance. The black hinder parts and the respiratory orifices are directed outwards.

Treatment.—The best is the careful removal of the animals with the forceps. Enticing them out with milk does not succeed, according to Pruner; touching them with a weak infusion

of tobacco is better. But if we are clumsy in seizing the animals with the forceps, they rapidly creep back. After their removal, the cavities which they have made and the excrescences in their neighbourhood soon heal.

b. The common Flesh-fly = *Sarcophaga* = *Musca carnaria.*

This also occurs sometimes in external wounds or ulcers in the human body, as it lays its eggs in which the larvæ are usually ready formed, or its larvæ, which sometimes leave the egg even within the body of the mother, on every animal structure or nutritive material derived from the animal kingdom subject to the laws of decomposition. In the latter case the young immediately begin to eat. In the heat of summer and in hot climates the larvæ easily get into badly managed putrid, and open wounds; nay, even the short time occupied in dressing is sufficient to enable the fly to deposit her brood in them, if particular care be not taken. Attracted by the smell, this fly, as well as the preceding, deposits its eggs and larvæ in the vagina of little girls or women when they lie naked in hot summer days upon dirty clothes, or when they have a discharge from the vagina. In malignant inflammations of the eyes, the larvæ of this and the preceding fly even nestle under the eyelids, and in Egypt, for example, produce a very serious addition to the effects of smallpox upon the cornea, as, according to Pruner, in such cases a perforation of the cornea usually takes place.

c. The larvæ of *Musca domestica* and *stabulans.*

These larvæ sometimes occur in sores, or in the vagina of girls. Thus, for instance, I have seen a nest of them in the vaginal orifice of a little girl in the summer, and removed them by injections of chamomile. The eggs of the common house-fly, according to Leuckart, are only a little smaller than those of the bluebottle, and very similar to them in form. They are, however, more pointed towards the anterior pole, and have a thicker chorion, which becomes as much as $\frac{1}{350}'''$ in thickness at the poles. The chorion has wide pits and facets. At the poles the pits

become regular, perpendicular canals, which terminate in blind ends towards the inner surface of the chorion. There are also two ridges, twice as far apart as in the bluebottles, but not much elevated. A deep furrow runs along upon the ridges, and the arched portion by which they are united below the anterior pole, and enters deeply into the chorion. The folds and ridges diminish and disappear towards the posterior pole; the micropyle forms a funnel-shaped pit, which is not distinguished either by a clear space, or by mouth-piece-like appendages, and forms a distinct canal passing through the chorion, the inner opening of which is connected with the vitelline membrane. The albuminous layer of the mature ovarian egg is the same as that of the bluebottle with its anterior projection.

It is also reported that the larvæ of the three last-mentioned species have been found in the urinary passages, in the urethra, &c. A great part of these cases are undoubtedly to be regarded as illusions, and many larvæ accidentally placed in the chamber-pot may have been regarded as having been passed from the urethra. Nevertheless it is quite possible that the larva of a fly may get into the urethra, especially in blennorrhœa or in sores on the penis; or in cases of gonorrhœa uncleanliness, and abundant formation of smegma, especially in hot countries, these larvæ may have been seated under the prepuce, and hence have passed into the chamber-pot.

The maggots of the flesh-eating flies occurring in the human stomach and intestines, certainly get into the alimentary canal by the use of decaying cheese, spoilt ham, and other cold meats, during the latter part of the summer and the autumn.

Upon the larvæ of the flies in general, consult Von Siebold, in R. Wagner's 'Handwörterbuch,' l. c., pp. 683—685.

Sub-Order—Nemocera.

Corpus tenue, longum; caput parvum; thorax brevis, arcuatus; proboscis varia; palpi longi, saltem 5-*articulati; sæpissime cristati; antennæ tenues, longæ, filiformes,* 6: *et ultra articulatæ, horridæ aut pennatæ; pedes tenues, longi; alæ longæ et tenues.*

We should only have to do here with the true *gnats* (= *Tipulida*) and the *Sand-flies* (= *Simulida* = *Mosquitos*), of which the former have a short, thick proboscis, with two distinct terminal

lips, and two setiform maxillæ in its interior, and thin five-jointed palpi either hanging down or bent; the latter are distinguished by their prominent eleven-jointed antennæ, becoming thinner at the apex, and have a projecting proboscis, broad wings, and no ocelli. As, however, they are in general too well known, and only attack men for a time in order to obtain their nourishment, we shall not pay further attention to them in detail, but herewith close our examination of the parasites occurring on the human subject.[1]

Amongst the parasites belonging to the class of Helmintha the reader will miss—1, the *Dactylius aculeatus,* and 2, the *Spiroptera hominis* from the urine. The former was placed by Von Siebold with the *Naides,* and by Henle with his new genus *Enchytræus;* it is undoubtedly only an animal of the family of the *Lumbricini* which had got accidentally into the urine.[2] (See Von Siebold, l. c.) The latter, according to Bremser, was a young *Strongylus gigas.* 3. The *Diceras rude* = *Ditrachyceras rudis,* recognised as the seed of the white mulberry. 4. *Diacanthus polycephalus,* as a raisin-stalk evacuated *per anum.* 5. *Sagittula hominis,* as a fragment of the hyoid bone of some bird passed with the fæces. 6. The *Ascaris alata,* found in the small intestine of a man, is probably only a young individual of one of the long-known Nematoda, if indeed it be a worm at all. 7. Bushnan's worms, which were found in the blood an hour after bleeding, were the larvæ of *Tipula oleracea,* according to Rhind, and accidentally introduced: red larvæ of *Chironomus,* according to Von Siebold. 8. The *Filaria hominis bronchialis* of Treutler, as already observed, may be identical with the *Strongylus longevaginatus* of Jorsits (Diesing). 9. The *Hexathyridium venarum* of Treutler and Delle Chiaje was probably *Pisciola geometra,* or some other planarian inhabitant of the fresh water, which had got into the vessels with the water employed in bathing the feet, &c. 10. The *Polystoma pinguicola,* Zeder = *Hexathyridium pinguicola,* Treutler, an animal 8‴ long, 2—3‴ in thickness, oval, convex above, impressed beneath, furnished with six pores

[1] See Appendix A.

[2] The history of these animals is given in Appendix C, vol. i.—Trans.

at the anterior extremity, and a larger abdominal aperture before the tail, found in an ovarian fat-sac, is in my opinion so doubtful, that I think I am justified in leaving it out, although Bremser figures it amongst the Helmintha. Treutler thinks that this animal resembled the *Linguatulæ;* and although other views have been recently put forward, I cannot help considering the thing as impossible. Errors are very possible, especially with such low powers as Treutler appears to have employed. The animal in question cannot well have been a *Polystomum,* which has hitherto only been found in the air-passages of fishes or the urinary bladder of the frog. It might, however, be possible that the animal, if no *Linguatula,* was a dead hexabothrious scolex of a Tænia, which had either lost its hooks, or had not yet come to their formation. Since we have learnt how to produce *Cysticerci* artificially, it will be admitted that those forms of cystic worms have a very great similarity to *Linguatulæ* in their external form. 11. Brera's *Cercosoma* in the urine were nothing more than the larvæ of *Eristalis tenax,* so common in privies, and which had got accidentally into the chamber-pot. 12. The parasites given to Von Baer as having been passed with the fæces, which Von Baer recognised as larvæ and beetles of *Ptinus fur.* It afterwards appeared that the night-chair of the patient in question had a torn cushion on its seat. In putting on the cover, these insects fell into the pan. 13. The hexapod larva of *Clerus formicarius* was given to Von Siebold as a urinary parasite. Both as a larva and beetle this animal preys upon the bark- and wood-beetles, such as the *Anobia,* which live in wooden furniture and in the rafters and deals of rooms and houses. It might, therefore, easily have got accidentally into a chamber-pot. The larvæ of the churchyard-beetle (*Blaps mortisaga*) and the woodlice (*Oniscus murarius*) have also made their appearance as parasites.[1]

[1] The most ancient example of pseudo-parasites occurs in Plutarch's 'Symposiacon,' viii, quæst. 9, cap. 3. After the quotation about the *Filaria medinensis* he tells of a person suffering from dysuria, from whom a jointed barley-stalk passed out of the urethra. Probably the individual had first (*horribile dictû*) put it into the urethra himself. Plutarch then narrates: "And of our guest-friend Ephebos at Athens we know, that simultaneously with much semen he evacuated a very hairy animal which ran along rapidly with many feet." Whether in this case a woodlouse, or if "δασυ" should signify "rough, hard," an earwig had penetrated into the urethra of Ephebos, and excited a pollution, we cannot say. Perhaps even the worm only came subsequently to the

According to the plan developed by me in the definition of the idea of parasites, I must, of course, also omit those articulated animals which only wound men when they are irritated, or do not live at all upon his juices. These are—1. The scorpions (class *Arachnida;* order *Araneida;* series of the cancroid Arachnida, family of the scorpions, of which we know the sub-families—*Scorpio, Buthus, Androctonus,* and *Centrurus*). The common European scorpion (*Scorpio flavicandus, europæus, germanicus, terminalis,* which are only names for varieties of the same species) has six eyes, and can only produce local phenomena, which are said to disappear by treatment with oils or ammonia, and in which, perhaps, collodion would prove useful. It is supposed that the effects increase with the age of the animal, and with more southern climates. The eight-eyed *Buthus afer,* which is especially an Indian species, is said to be much more dangerous. Only local phenomena, can be laid to the charge of the twelve-eyed *Androctonus* in Algiers. (On the scorpions in Algiers and their poison, see Moritz Wagner, 'Reise in Algier,' iii, p. 255.) 2. The true house-spiders (order *Araneida;* section *Araneida;* first sub-section *Sedentariæ* = weaving spiders; family *Epeira* [geometric spider], *Tegenaria* [house-spider], and the Italian *Malmignatte* [*Latrodectus Malmignatus*]). Their bite scarcely inflicts a worse wound than that of a flea. However, some of the larger, southern spiders may be more dangerous. Treatment with cold applications (cold earth or collodion) is sufficient. It may also be mentioned that a hysterical patient of Lopez pushed spiders under her eyelids, in order that the surgeon might remove these parasites. 3. The hunting spiders (*Lycosida,* according to others *Vagabundæ*), the third sub-section of the section *Araneida,* to which the celebrated *Lycosa tarantula* belongs. In Walkenaer's 'Tableau des Arachnides,' p. 11, and in his 'Hist. nat. des Insectes Aptères,' i, p. 291, note, and ii, p. 499, we find the literature referring to *Tarantulism.* Ferrante is the first who referred to it. Many are inclined to regard the tarantula dance, which was said to occur after the bite, as a sort of *chorea.* It appears to me

emission. This passage is, also, interesting from the narrative that Timon's nurse annually fell into a somnambulic sleep for two months, and also from its letting us see that the ancients were already acquainted with delirium tremens. *Καὶ μὴν ἔν' γε τοῖς Μεμονείοις σημεῖον ἡπατικοῦ πάθους ἀναγέγραπτα, τὸ τοὺς κατοικιδίους μῦς ἐπιμηλῶς παραφυλάττειν καὶ διώκειν ὅ νῦν οὐδαμοῦ γινόμενον ὁρᾶται.*

that in this case too little reference has been made to the following circumstance. It may probably happen that in particular cases the bite of the tarantula may produce violent local irritation, and that perhaps it was observed accidentally by the people that violent dancing and keeping up the perspiration in bed quickly healed these local symptoms. To excite a desire of dancing in those who were bitten, and thus to obtain a perspiration, it is well known that two melodies were played—the Tarantola and the Pastorale. Subsequently this circumstance was confused or forgotten, and in course of years it came to pass that as soon as any one was bitten by a tarantula, they played to him and he was obliged to dance. Hence it might easily happen that people were unable to imagine a tarantula-bite without its being followed by music, and in consequence by dancing. Thus the bite and the remedy came to be so mixed up together, that the people, and with them Ferrante, could no longer distinguish between the two. The bite is a product of the animal, the dancing a product of the music, as we may see every day in ball-rooms. 4. The bees, and humble-bees, wasps, and hornets (order *Hymenoptera;* series of the bees = *Apida,* families *Apis* and *Bombus;* series of the wasps, family *Vespida,* sub-families *Polistes* [paper-wasp = *Polistes nidulans*], *Vespa* [*vulgaris* = the common wasp, *V. crabro* = the hornet, and *V. holsatica* and *britannica,* of which the latter are probably identical]). 5. The ants (order *Hymenoptera;* series of the ants, family *Formicida;* sub-family *Formica*).

Of course we need not speak here in detail of the caterpillars, toads, and snakes, which may accidentally wound and poison men with their bite; nor of the lizards, if any of them are really venomous. They would not be mentioned here at all, if the popular belief had not regarded some of the last-mentioned animals, as well as salamanders, frogs, and tadpoles, certain caterpillars, centipedes, beetles, &c., as actual parasites of man, and supposed that these animals, nay, even some species of fishes, such as the eels, could carry on a parasitic existence in the interior of the human intestine. Unfortunately the medical men have given their assistance to this nonsense; and I myself have seen one allowing himself to be fooled by a patient with an eel, and another with a frog. With such follies there are only two ways of dealing—jest and scientific experiment. The former has been done, and many perhaps are acquainted with the satirical tale in which

a medical man in recent times has castigated a fool of this kind, who chattered about the presence of living frogs in the body of a patient, in the same style in which Dr. S. C. H. Windler (Schwindler) once derided the Infusorian theory of the process of fermentation. But such remedies are not thoroughgoing, and cannot effect a fundamental cure. For the cure of these follies we are indebted to Berthold, of Göttingen (see 'Nachrichten von der G. A. Universität und der Königl. Gesellschaft der Wissenschaften zu Göttingen,' No. 13, 1849), and I here reproduce literally his conclusions.

1. All observations on living amphibia having remained long in the human body, and, acting as the cause of long illnesses in it, are false.

2. Eggs of amphibia when swallowed very soon lose their power of development in the stomach. (Dr. Kretschmar, of Stolpen, informed me as an analogous case, that trout often devour fertilised trouts' eggs at the spawning time, but that these eggs when again taken out of the stomachs of the trout and put uninjured into fresh water, do not become developed.)

3. It is, however, possible that amphibia may get into the human subject by intentional or accidental swallowing.

4. Such animals may be again evacuated either in a living or asphyxied state, when vomiting takes place soon after they are swallowed.

5. If this vomiting only takes place at a later period, the animals thrown up are dead; if no vomiting take place, the animals are more or less digested, and we find either their epidermis or bones, or nothing at all of them, in the fæces.

6. The only and true reason why the amphibia cannot permanently live in the human body is the moist heat of at least 80° F. (29° R.) which no species of amphibia (frogs of all kinds and frogs' spawn, the tadpoles of frogs and toads, salamanders, tritons and their spawn, lizards, and slow-worms were employed in the experiments) can resist from two to four hours.

The method of experiment was as follows: Berthold put the animals just mentioned in vessels with water and air, which were kept for two to four hours at the temperature of the stomach (29° R.)

The ordinary caterpillars also belong here; they soon died even at a low temperature in water. They can get into the stomach with salad, or in as far as concerns the smooth sixteen-footed cater-

pillar of *Aglossa pinguinalis,* which lives in old fat or butter, and is therefore frequently found in the kitchen and cellar with fat articles of food. (This caterpillar was found by Rolander and Linné in the fæces or vomitings, and regarded by the latter as very dangerous in the human intestine. If they are soon thrown up, they are either still alive, or retain their form; but if this take place later they must bear more or less distinct traces of digestion about them. In the fæces they can hardly be found again, or only in cases of very imperfect digestion, and with violent diarrhœa to drive them very rapidly through the intestines. The same applies to the *Gordius aquaticus,* which, however, from the hardness of its epidermis, may perhaps long resist, if not death, at least digestion. It might probably reach the stomach by the use of worm-eaten fruit. We know nothing of species of *Mermis* accidentally getting into the stomach with water, &c.)

In southern countries leeches (*Hæmopis vorax*) are readily swallowed with water, and these are said to be able to live some time in the human body, causing violent internal hæmorrhages. This is mentioned by Larrey, and it was also experienced at the siege of Mahon.

Lastly it may be stated, that hairs, fibres, and undigested flesh, passed with the fæces, have been described as parasites of man. The careful practitioner will be easily able to avoid mistakes.

The hair of the processionary caterpillar (*Bombyx processionea*), which forms on oaks a bag-shaped cocoon often as large as a man's head, is very dangerous to man.

Nicolai's researches and observations ('Die Wandert oder Processions-Raupe,' Berlin, 1833) have proved that the caterpillar usually appears during the middle of May, at first to the number of from ten to twelve, on the bark of the oak, from whence it wanders to the first buds and twigs of the oak. Each single caterpillar is from 3—4''' in length, and of the colour of the bark of the oak. They have long stiff black and white hairs or bristles, and a black stripe on the back. This little band of from ten to twelve caterpillars (probably relatives) keeps together on a twig, and eats during night and day. They grow rapidly, learn to move more quickly, upwards of 100 and more uniting and forming a wandering colony in order to attack larger branches. They wander thus from twig to twig, casting their

skin for the first time towards the end of May by rubbing against the uneven bark of the oak. They are now of from one third to one fourth of an inch long, of a grey colour, distinctly showing twelve segments, and on the top of each segment a black shield with very short, velvet-like hair of a peculiar lustre. The large hairs are ranged in from two to three bunches on each segment, having lower down on their sides eight spiracles and eight pairs of legs.

During the time of the casting off of the skin, the grey caterpillar becomes yellowish-brown, lustreless, stronger, but lazier. The caterpillars mostly gather where a branch withers, and attach themselves so firmly by spinning a cocoon, that caterpillar and bark seem one. The cocoon is thin and transparent, and attached to its inner part is the cast skin. These caterpillars have quite the appearance of the former, and begin their wanderings afresh—a caterpillar leading each troop, having attached to its tail other caterpillars and so on. They grow now very large, and collect together at the end of June or the beginning of July in increasing numbers. The caterpillars, placing themselves side by side or one above the other, cast their skin a second time and wander again, leaving threads behind on the path of their emigration. They are now excessively voracious, and deposit largely the matter which is so obnoxious to men and animals. Being now more than one inch in length, and very strong, they are seen to make long journeys, annexing all smaller troops which they meet on their way. They gather at last on the trunk of a thick tree, placing themselves side by side to the extent of a man's hand, and then one above another in three or four rows, after which some of the larger caterpillars are seen to creep from underneath and spin all round the heap. The spinners are relieved by others at regular periods, and from six to eight caterpillars may be seen on the cocoon, which is usually fastened to the sunny side of the trees, rarely to the stormy and northern side, at a considerable height close to the twigs, and where a twig or branch is decaying. A hole is left in the cocoon for the passing in and out of the caterpillars, which is always guarded by several large caterpillars. These guards allow only larger caterpillars to pass, preventing all smaller ones which may happen to follow from entering, and appointing for their use a separate place close to the nest, from whence they are led by a larger caterpillar on new excursions to young leaves, the

leader returning to its nest. The larger caterpillars deposit fæces in the nest, which, falling among the threads of the cocoon, render the latter more opaque, and more capable of resisting external influences. This closing up happens usually at the end of July or beginning of August. Each caterpillar prepares for itself a separate case or cocoon inside the large cocoon, which is of a grey-yellow colour and silk-like appearance. The single cocoons of the caterpillars resemble, in the method of their spinning, that of *Bombyx mori*: they are, however, more oval, smaller, and very rich in the yellow powdery substance, of which we shall have to speak. The cocoons are formed in one night. The butterfly escapes towards the end of August, by softening the threads of its cocoon with its saliva, (?) and thus dissolves them. It copulates, lays eggs, and dies. Many of the chrysalides in the cocoons were destroyed by white, worm-like, hairless parasites.

The inhabitants of Westphalia are well acquainted with the important and dangerous diseases and sufferings which are caused by these caterpillars both in men and animals. It is very doubtful whether the noxious substance which acts like a poison, creating redness, itching, and burning of the external and inflammation of the internal parts, and causing even death, consists of the long hairs of the caterpillar. According to some writers, the nest or cocoon is to be looked upon as the cause of these disorders; whilst others say that they are caused by an acrid noxious juice which the caterpillar is thought to secrete when it creeps over the surface of the skin. Nicolai convinced himself of the impossibility of the latter cause, for he observed itching pustules on his forearms which were covered with clothing, though the caterpillar had never come near them. On one occasion, when attempting to attach to a board a large caterpillar by means of pins, and for this purpose piercing its black back shield, he saw on the edge of the shield a reddish-yellow, fine, dust-like, saffron-coloured powder proceed from the shield, without the latter being altered in the least. The interior of this spot showed no especial organ nor opening. Later observations, however, are said to have discovered underneath these reddish spots two large warts which almost touch one another, and which are especially noticed when the caterpillar casts its skin and has become deprived of its hair. The same dust was found by Nicolai in the nests and cocoons in the parts which surround

the chrysalis. The caterpillar also exuded this substance on being touched with a knife on the black shields. On coming into contact with the moist skin it caused, after eight hours, red itching pustules, but produced no effect when brought in contact with the dry or oiled skin. The dust loses its peculiar power by being preserved in spirits of wine. Ratzeburg observed that feeding the caterpillars shut up in a glass, and the necessary repeated opening of the glass, were sufficient to cause inflammation. Lameil, Physician to the Lunatic Asylum at Charenton, observed, after the lapse of ten years even, on opening a glass which contained a piece of a cocoon, similar effects. The microscope shows the dust to consist of very fine, straight, spiry, minute hairs beset with barbs. They are exceedingly light, swim on water, and are sometimes carried away by the wind, flying about for some time in the forest. The dust is carried on to objects and into the air by the creeping of the caterpillar on a damp place, by touching it, by moving through the air, and by the falling of drops of rain on the bark. This dust seems, however, only to be formed after the second and last casting of the skin of the caterpillar.

In places where the caterpillar is of frequent occurrence, the animals which come into the forests are attacked by various diseases. Sheep by inflammation of the eyes and violent coughing; cows and goats by the same symptoms, with internal inflammations and ulcers all over the skin, the violent itching of which makes the animals restless and drives them almost to madness; horses more especially suffer from it. The diseases of the eye caused by it are blenorrhœa of the conjunctiva, dimness of vision, and perforation of the eye. People become exposed to this poison by staying in a forest, by sleeping, working, or taking a ride, playing, cutting down wood even in winter-time, by gathering fruits, as strawberries which grow under the oak-trees, by collecting grass, litter, or the fallen leaves of forests. The diseases which follow are violent inflammation of the eye, erythema of the eyelids, blenorrhœa, coughing, inflammation of the throat and the lungs, violent itching and scalding eruptions of the skin (nettle-rash) and general fever; children who wear no trousers incur inflammations of the genitals, phymoses, leucorrhœa, and swelling of the labiæ, and finally also angina membranacea. The question is whether the above-described dust which is found, according to Nicolai, more particularly on the edges of the black shields of

each segment lining the shields with a brownish-red and delicate border, and which is velvet-like, very fine, lustrous, and soft, and which can be loosened and shaken away at the caterpillar's pleasure, be merely a mechanical or also at the same time a chemical irritant; opinions differ somewhat. Müller and Rabenhorst found a peculiar acid and a volatile oil on examining chemically the fir-weevil (*Bombyx Pini*) which offers similar conditions, without, however, experiencing any noxious effects from the oil or the acid. Ratzeburg believes that a poisonous volatile principle exists (analogous, perhaps, to the poisonous principle, of sumach, and other poisonous plants) which is simultaneously developed with the dust.

Treatment and Prophylaxis.—The destruction of the caterpillars by burning and singeing them by means of wisps of straw or by sweeping them off the trunks of the trees and crushing them on the ground, is always dangerous to the operator, since the dust is dispersed in the air. Obstacles to their migration, such as coal-tar, tarred paper, and digging trenches round the trees, are of no avail, as the caterpillar simply goes round them, and crosses even small brooks. I think it would be best to discover the nests and wrap them up with rags soaked in oil, and then to cut away the branch and to burn or bury it. It would be well, however, to destroy the insect in the chrysalis state towards the end of July or middle of August, before the butterfly creeps out, in order to restrict its propagation, or to hunt up and annihilate the latest brood which exists before the second casting of the skin without the dangerous dust. It would, therefore, be necessary to search from the beginning of May to the beginning of June for the wandering troops. The collector of nests and caterpillars will do well to use a blunt hoe, to wear gloves, and to oil the skin. There are generally only one or two nests in each tree. The caterpillar has but few enemies in the animal kingdom, of which I may mention the ichneumon. Birds seem to be afraid of it. Precautions ought to be taken to prevent persons entering infected forests by means of notices, by the digging of ditches, &c. The pasturing of animals in such forests and the gathering of fodder and litter should be forbidden. The gathering of fruits of any kind should be unconditionally interdicted, and, in case nests are discovered when oaks or pines are cut down, they should be carefully removed, as mentioned above, without hewing them

to pieces; and the woodcutter advised not to place himself towards the wind.

Direct treatment.—When the dust has been deposited on an individual, it is recommended by Ratzeburg to employ cold douche baths. Nicolai recommends milk poultices in the case of inflammations of the eye and the erysipelatous inflammation of the eyelid; rubbing in of oil on the more sensitive reddened parts, or applying fomentations or lotions with milk; when the throat or tonsils have become inflamed oily emulsions, salad oil, and milk are recommended; but if the bronchi and lungs are inflamed, a more powerful antiphlogistic treatment is required. Remedies which allay and restrict the irritation, especially emetics, when there is a tendency to sickness, and on the whole a quick and energetic treatment.

Popular superstition augurs a year of dearth from the appearance of this caterpillar and its migrations from west to south or from southern to northern countries.

Trousseau and Pidoux[1] have, as it is well known, endeavoured to make a therapeutical use of the hairs of this caterpillar, in order to bring quickly back on the skin exanthemata which had disappeared by employing them externally. I have already mentioned that the caterpillar of *Bombyx Pini* causes similar disorders. The latter differs, however, from the former, that the symptoms are generally a little milder. The hairs are not hooked but thread-like and in the shape of a lancet, at the same time smooth and even, though Müller (Ratzeburg's 'Forst-Insekten,' ii, p. 57) has observed that they sometimes cause death.

Wounds are said to become very malignant when the juice of the crushed caterpillar is pressed on them. I do not know whether the experiments which have hitherto been made be considered sufficient. In order to prove this fact it would be first necessary to separate the little hairs from the juice and then employ the filtrate for the experiment.

[1] 'Traité de Thérap. et de Mat. Méd.,' Paris, 1841, vol. i, p. 456.

VEGETABLE PARASITES.

VEGETABLE PARASITES.

GENERAL PART.

"All vegetable parasites which are found on animal bodies belong to the class *Cryptogamia*, and to the orders *Algæ* and *Fungi* exclusively."

The medical man attends more particularly to those forms which are met with in man, and all the parasites treated of in the present work belong to the most simple plants, sometimes merely formed by the aggregation of a number of cells, and they can, therefore, scarcely be of a very complicated nature. Amongst them the *Algæ* are distinguished from the *Fungi* by chlorophyll, or some other colouring substance, which is observed at their generation or soon after, and before the time when they leave the parent-cell. If each cell is considered separately, the smallest appear to be colourless, but are seen to be distinctly coloured when they are aggregated into a mass.

The investigation of the medium on which these parasites are found is of importance for therapeutical purposes, and we propose to view—

1. The solid ground or soil which affords them nourishment.
2. The gaseous medium which surrounds them.
3. The influence of physical agents upon them.

1. No plant can thrive on a merely mineral soil, but requires, at the same time, organic substances; if, therefore, parasitical plants are to thrive, the animal system on which they live must needs suffer from disturbance or want of nourishment, and a simultaneous retardation of the change of elements. In consequence of these changes, the renovation of the atomic elements of the tissues and of the fluids proceeds so slowly, that the spores

which spread themselves on the surface of certain organs have time to abstract them for their own use. This is the common requirement of all parasites, and, just as those which live on other plants are chiefly met with on the epidermis (of the leaves or bark), which is remarkable for its slow and weak assimilation, so we find those living on animals preferring those parts which are slowest in changing their elements—as scales, shields, wing-covers, shells of muscles, epithelium, epidermis, &c.; or they occur in tedious diseases which are followed by weakness, or a retarded and slower reproduction when the molecules of the tissue appear to have been retained too long. On animal mucous membranes such formations which undergo a slow metamorphosis are produced upon the epithelium in spurious membranes, or by a diseased, acrid *mucus*. Similar changes are observed when a retardation in the change of elements takes place, in consequence of the wearing out of the spinal marrow in the Batrachia, when *Saprolegnia ferox* begins to spread most luxuriantly. Deposits of food which stick to the teeth, or, in certain insects, to the folds of the mucous membrane of the peritoneum, and which undergo in these places a retarded metamorphosis, produce similar effects. Here we have the analogue of the great *theory of "manuring,"* without which agriculture could not exist, nor could vegetable parasites thrive. This constitutes, also, the principal difference between the nourishment of animal and vegetable parasites. The former live upon the fresh juices and supplies of their host, which they first decompose or assimilate; the latter live on and take up their food from substances already in a state of decomposition. When the spores of the vegetable parasites become once fixed, they take their food either externally from the medium which surrounds them—which rarely happens with the vegetable parasites found on man; or their presence causes the soil (*i. e.*, the tissues) to be saturated with a peculiar fluid which changes in the air or not, and which may lead even to suppuration. All this greatly favours the rapid growth of *Fungi*. We have a good illustration in *muscardine*, where the animal itself (the silk-worm) shows the first signs of disease, and as soon as the fungus known under the name of *Botrytis* has fixed itself, the circumstances favorable to its development are increased by its very presence. Artificial vaccination of vegetable parasites is the more successful the more diseased the animals are which are employed (see the experiments of Hilling and Hannover on

vaccination with the spores of *Saprolegnia*, &c.) The fitness of the soil is, moreover, increased by the humidity, which increases daily and steadily in consequence of the germination of the spores, and which is favorable to the growth of the plants. It is always a sign favorable to their growth if this moisture shows at first a slight acrid reaction; this is, however, not so very indispensable as has been commonly thought, since many *Fungi* grow on neutral or alkaline soil; as, for instance, in the peritoneum of the Herbivora and on ulcers of the trachea.

Fungi prosper the more the richer the soil is in organic nitrogenous substances, especially in such as are in a state of decomposition.

Here also we find exemplified the great law which must be obeyed wherever plants are to prosper: "*The choice of the locality depends upon the peculiar properties of the soil sought for or avoided by the various species of plants.*" For certain species prefer certain parts of their animal host.

2. The nature of the gaseous medium seems quite indifferent to the development of vegetable parasites, for they are found in atmospheric air when on the skin, in an air rich in carbonic acid when in the cavity of the mouth and lungs, in an air not overcharged with carbonic acid gas when in the peritoneum. Thus, for instance, the *Algæ* of the process of fermentation thrive best in an atmosphere rich in carbonic acid, whilst the *Fungi* appear to absorb oxygen and give off carbonic acid. Humidity of the surrounding gaseous media (humidity of the atmosphere, humidity in the cavities of the body which contain air) favours the development of these parasites.

3. Most favorable for the development of vegetable parasites is the temperature of the body of the mammalia, especially in their natural cavities. Their growth may be increased in cold-blooded animals by raising the temperature of the surrounding air.

A knowledge of the circumstances which favour their growth enables us to form a "general theory of the treatment of vegetable parasites." We have chiefly to look to a change in the medium in which they grow, and to bring on a state in which they cannot thrive so well. Of late Bazin has done much towards advancing this department of science; his method contemplates more particularly the locality of the parasite, which it endeavours to change, and makes direct war against the predisposing disease by

employing parasiticidal means, and strengthening and improving the system.

Physiology of vegetable parasites.—They all show—

1. *Nutrition.*—Assimilation may be recognised distinctly, or only indistinctly or not at all. The products of secretion are none or very sparing. Sometimes a few drops of oil are found on the surface or underneath the spores, and even these may be viewed as the product of the transformation of the amylaceous or nitrogenous matter in plants.

2. *Development.*—This varies according to the species, it is, however, generally speaking, very rapid everywhere with vegetable parasites, in consequence of the predominant assimilation.

3. *Reproduction.*—This function is likewise very intense and rapid. The spores spring up rapidly in masses, and are capable of a very easy dispersion either by currents of air carrying the spores, or by water in which they are frequently whirling about.

Effect of the parasite on its host.—The spore of the parasite germinates as soon as it has settled down on some part of the body, or it penetrates first deeper into the body underneath the epidermis, or in the open cavities of the body. The spores penetrate rarely deep at first, but almost all will do so as soon as the filaments of the mycelium are formed, which penetrate rapidly the surface of the membranes and tissues, disturbing the functions of these parts, and killing smaller animals sometimes in two or three days; as, for instance, the eggs of reptiles and fish (as those who endeavour to rear fish artificially have to their cost experienced), or the *Batrachia* themselves, upon whose skin they frequently settle down. The penetrating of the filaments is sometimes merely mechanical into readily formed cavities of the body, as in the follicles of the hair; sometimes it is caused by the elevation of the epithelium. It is, however, soon followed by organic action, since the hard and specifically heavier spore presses upon the soft tissue underneath and causes resorption in such places. The same occurs when the action of the organ on the spot where it lies presses it in deeper, or when its constantly increasing size causes molecule after molecule to be subjected to resorption underneath its weight. It may at the same time be observed that the process of germination, which goes on everywhere in nature with an unmeasurable display of power—a process by which the hard husk of the vegetable seed (spores) is rent, and the young plant enabled to push aside the soil, to lift and to break

up, and to drive it asunder likewise in a downward direction in order to prepare a bed for its roots; that the same display of strength takes place on the human body, and thus enables the spores, filaments, mycelia, &c., to penetrate its tissues. Mechanical causes determine, therefore, the spores in penetrating deeper into the under-lying tissue, and producing atrophy of the fibres of the skin in these places. The cells containing the fat disappear, as a section of the skin will show, and a cavity is formed which is thinner at the spot where the growing parasite has fixed itself. According to Robin, the eggs of the Helminthæ perforate the kernels of melons, apples, and cherries, and the intestines themselves, in accordance to the simple laws of mechanical pressure. Inflammation of the tissue does not necessarily take place in these places, although of little concern; but a certain amount of swelling, with or without the formation of pus-globules, may be observed round the place of deposition (the cavity). A favus-crust is formed, when the exuded mass coagulates and becomes mixed with epithelium. This explains the migration of the mycelia into the interior of the tissues and into closed cavities just as easily as the migration of other foreign bodies from one place of the body to another. The latter frequently takes, instead of the molecule placed and resorbed *before* the foreign body, another molecule on the opposite side, that is *behind* the foreign body, and helps thus to push it forward.

Prognosis. — The preceding characteristics enable us, moreover, to gain an insight into the kind of injury which the parasites are able to do. They produce scarcely any critical symptoms, at the utmost a slight disturbance of the bodily functions, whilst they are restricted to a very small space, and live on animals of considerable size. The quicker, however, they grow, the more bulky they become; the more important the organ is which they choose, and the more diminutive the body of the chosen host is, the more obnoxious becomes their influence on the host, and his very life may even be endangered by them.

Absorption and penetration must not be confounded. The vegetable parasite absorbs, by receiving liquid constituents into its system without any change of the organic masses; and it penetrates, since it is a solid body which penetrates another body, the tissues of which vanish beneath it by resorption; and this it does without changing its own condition.

Parasitical plants as the causes of epidemic diseases.— Without

being able to prove it with certainty (we need only think of the cholera-parasites, which proved to be quite chimerical), epidemic diseases have, from time to time, been accounted for as produced by certain microscopic vegetable parasites. Robin is quite right, when he says—"This whole hypothesis is merely an attempt of medical men to seek the external conditions of the existence of universal affections in the changes of the internal constitution of beings, their atoms and molecules. Should there really be such vegetable parasites discovered in epidemic diseases, they might rather pass for consequences of the epidemic disorder of the fluids which has set in, than for the causes of such epidemics." It is, unfortunately, not yet quite clear what disorder of the fluids is necessary to make a single parasite thrive well. The disputed question, when better decided than it is now, as to whether certain vegetable parasites, when transferred to any organism (no matter whether healthy or diseased), can develop themselves well, or whether they thrive only on special organisms, will enable us to decide the first question with greater certainty. All observations are yet incomplete; and we entirely lack elementary observations on the temperature and degree of humidity of the atmosphere, which are certainly of no little influence, during some seasons or years, with regard to the more frequent, almost epidemic appearance of certain vegetable parasites.

Literature.—Principal work, 'Histoire naturelle des végétaux Parasites qui croissent sur l'homme et sur les animaux vivants,' par Charles Robin (avec un Atlas), Paris, 1853.

SPECIAL PART.

A. Algæ.

Plantæ aquaticæ acotyledoneæ guttatim submucosæ, granulosæ floccosæ, gelatinosæ, membranaceæ vel coriaceæ; filamentosæ vel tandem foliosæ; olivaceæ purpureæ virides leucophoeæ, albicantes vel raro achromaticæ; cellulares; cellulis minutissimus isolatis, vel filamentose aut floccose articulatis, aut in filis cum muco aggregatis vel tubulosis et continuis vel articulatis-prosenchymaticis vel parenchymaticis formatæ. Sporidia nulla in minimis unicellularibus, holo vel partim gonimicis, aut in pericarpiis inclusa aut superficei inspersa. Quædam dioicæ.

1. *Sporidia cellula unica immota vel ciliis moventia* (*zoopora*).
2. *Spermatozoidia numerosa ex cellula unica "in antheridiis inclusa dein libere moventia."* Kützing.

The vegetative system, which, in other plants, consists of "*phycoma,*" is the vegetative system in general; "*cauloma,*" the stem, and "*phylloma,*" the branch, is represented in the Algæ by the "*cœloma,*" or *tubus,* and "*trichoma,*" or *filamentum.* The parasitic Algæ found upon living animals consist of cylindrical or flattened filaments, single or branched, frequently with dissepiments, or apparently articulated at certain distances, and containing greenish or grayish molecular granulations in varying quantities. Each of these granular masses is called a "*gonidium,*" whilst the granulated cell-contents is called the "*endochrome.*" The tribes of these Algæ have no special apparatus for fixing them in the mucus of the affected animal, but they are held firm by the crossing of the fibres.

The reproductive system consists of the sporangium and the spores.

The *sporangium,* conceptacle, or spore-case, is the organ in which the spores originate, are developed, and enclosed. It is formed from a variously shaped vesicle, which is universally of larger size than the cells of the vegetative system, and originates

in the extreme cell of a tube whose contents serve for the production of the spores.

The spores, sporules, *corps, reproducteurs, sporidia, spora, sporulæ, corpora* or *cellulæ gonimicæ, spermatia,* &c., are round or oval bodies, containing universally in their interior finely granulated corpuscles. They vary in size, but are easily distinguished either by their appearance or their germination.

Man, according to Robin, grows on his body ten species of Algæ, distributed in five genera; or if the five species of *Leptomitus* are to be regarded as one, then five species in five genera; or if the genus Leptomitus is regarded as a depauperated fungus, which will not fructify because deprived of the air (Robin), then four species in four genera. They all belong to the class *Isocarpeæ,* and the order *Eremospermeæ,* with the exception of *Merismopœdia Ventriculi,* which Meyen has placed in the tribe *Palmelleæ.*

I. *Cryptococcus Cerevisiæ.* Tab. I, fig. 1.

Class—*Isocarpeæ: "Fructus verus* (*cellula*) *in singularibus speciebus uniformis; spermatia vera matura* (*cellulæ*) *semper olivaceo-fusca, ex cellula hologonimica formata."*

Sub-class II—*Malacophyceæ: "Phycoma ex cellulis organicis* (*gelineis, anylideis, gelatineis, fucineis ve*) *compositum, interaneis, gonimicis, viridibus, raro rubris vel achromaticis."*

Tribe—*Gymnospermeæ: "Spermatia ex cellulis vel superficialibus, vel subcosticalibus medullaribusque formata, nec spermangio communi inclusa."*

Order I—*Eremospermeæ: "Spermatia in superficie phycomatis sparsa."*

Sub-order I—*Mycophyceæ; "Algæ mucedine plerumque achromaticæ, raro luteolescentes vel rubræ in corporibus organicis vel in solutionibus crescentes."*

Family—*Cryptococceæ: "Globuli gonimici minutissimi solidi mucosi, in stratum indefinitum aggregati."*

Genus—*Cryptococcus: "Globuli gonimici in stratum amorphum diffusum aggregati."*

Species—*Cryptococcus cerevisiæ.*

Synon.: *Torula Cerevisiæ* (Turpin); *Cryptococcus Fermentum.*

This plant must not be confounded, as has been done by

Vogel, with *Mycoderma Cerevisiæ,* which grows on the surface of *Cryptococcus Cerevisiæ,* and is a species of *Leptomitus.*

Description.—" *Cryptococcus cellulis achromaticis, globosis aut ovatis, corpusculo interno (nucleus?) hyalino notatis; diam. plerumque* 0·007 *interdum* 0·005—0·003 *mm.*

Variety.—*C. concatenata* (Kützing). " *Cellulis ellipticis vel oblongis in trichomata abbreviata ramosa concatenatis, corpusculis internis interdum binis.*"

It is found in yeast, diabetic urine, in the mouth, stomach, œsophagus, &c.

This parasitical plant is composed of round or oval cells, which often present in their interior one or two little corpuscles, which are more like globules of oil, or the nucleus of a cell, than a vesicle. They are propagated by small projecting bodies on the sides of the cells, which, when they attain the size of the parent-cells, give origin to new germs, and form a row of from three to five elongated cells, but never a cylindrical stem. In the air it immediately decomposes, on account of which it does not fructify in the air as the *Fungi.* The presence of one or two brilliant, strongly refractive globules in the interior of the cells, and which are often regarded as globules of oil, is very characteristic. Hannover and Vogel have not taken this circumstance into consideration; they have confounded the spores of various species of Fungi with the cells of this Alga, and have falsely supposed that all vegetable bodies with round or tubular forms constituted an especial variety.

Locality.—This Cryptococcus is developed morbidly in the secretions of the œsophagus, the stomach, or the intestines, or is introduced into these situations by means of beer. Hannover found it in the black fur of the tongue of persons labouring under typhus; Lebert, in the mouth of a woman who had long previously suffered from disease of the womb; Vogel, in fæces and vomited matter; Robin, in the bitter fluid vomited by a woman who, after fasting many weeks, ate some decomposing apples; Gruby, in a woman who had for eight years laboured under hysteria, accompanied for four years with daily vomiting (the vomited matter consisted entirely of an agglomeration of *Cryptococcus,* with mucus, saliva, and the remains of the food—as the Cryptococcus seems to have the power of developing itself on the inner coat of the stomach in the same way as the *Champignon du Muguet* in pharyngeal diphtherite); Bennett, in the vomited

matter from a cholera patient (the so-called "cholera fungi" of Swayne, Brittan, and Budd, which they found in the stools and vomited matter of cholera patients, and which the latter found in the water and the air of the affected place, seems to be nothing more than the ferment-alga, as has been pointed out by Baly and Gull, Griffith, Bennett, Robertson, Robin, and others[1]); Vogel, Ilmoni, and others, found this fungus in diabetic urine, and also in the urine of patients affected with scarlet fever. Thus showing that sugar was not necessary for the production of this fungus. Herapath and Quain also found it in the urine of cholera patients.

The development of this plant goes on very rapidly when it is in contact with decomposing substances, or liquid acids at a favorable temperature, as in the intestinal canal. But in all

[1] [Many other bodies besides the spores of *Cryptococcus* were regarded as cholera fungi. The following observations were made at the time of the discussion of this subject by Professor Busk, who was then president of the Microscopical Society of London, at one of the evening meetings of the Society. He stated that he should confine his attention to the papers of Dr. William Budd, Dr. Brittan, and Dr. Swayne, each of whom had written papers and given drawings of bodies which they supposed to be fungi. In the first place, he remarked that amongst the varied bodies figured by these gentlemen there was only one set that bore so strong a resemblance to each other as to claim anything like a common character. With regard to the figured bodies from air and water they were not definite enough to yield any possibility of classing them with one body or another. With regard to the more definite bodies figured by Drs. Budd, Brittan, and Swayne, and found in their preparations, he had with one exception found these in the matter passed by cholera patients on board the Dreadnought. These bodies, which were described as fungi, were of three different kinds. First, there existed a cellular body, which was more particularly figured by Dr. Swayne, and existed in two of his preparations, one in the possession of Dr. Lankester and the other in his own, which evidently exhibited the characters of the spore of a uredo, and on examination of some specimens of uredo from a loaf of bread bought at a baker's, it was found to correspond precisely with the spore of the cholera patient. As this species of fungus was very common in bread that had been kept and easily resisted the digestive action of the stomach, the presence of it in a few cases was well accounted for. The second class of bodies, and which under a high magnifying power, with a bad light, looked exceedingly like the last, consisted of small portions of the inner membrane of the grain of wheat. In the coarser kinds of flour this membrane was not separated, and he had no doubt that these bodies were introduced with the bread eaten as food. A third form of these more definite bodies was evidently due to the presence of undigested starch-granules. Drawings of all these bodies were exhibited, and their strong resemblance to the bodies figured by the Bristol observers was at once recognised. In conclusion, the author stated that he did not wish to pronounce an opinion that the existence of a vegetable organism as the cause of cholera was impossible, but from the observations he had now laid before the Society, he considered that such a cause in the production of cholera had certainly not yet been demonstrated. (*Daily News*, Oct. 19th, 1849.)] TRANS.

cases it will be found the fermentation has commenced previous to the development of the Cryptococcus.

It is of great pathological importance, as has been pointed out by Vogel, to regard this plant only as an accompaniment, and not as the cause of fermentation. It is an epiphenomenon—a result of the altered condition of the fluids—which have assisted its development; but it is never the cause of the change in the fluids, or of the accompanying vomiting. Hence there is no other method of treatment than a constitutional one.

In the loose stools of sucking children, according to Wedl, a rich formation of fungus is a common phenomenon. It is found, however, with difficulty, and only in thin divided layers of the fæcal mass, and after treatment with the carbonates of the alkalies. According to Frerichs, these fungi are more frequent in the large intestine than in the stomach, and are the forerunners and accompaniments of the spontaneous decomposition of the lower part of the intestinal canal. An oval or elongated cellular fungus, with free transparent globules in its interior, has also been found by Frerichs in the large intestine, and a similar form in the small intestines of the rabbit. (See Tab. I, fig. 1, vol. ii.)

Literature.—Vogel, 'Icones histol. pathol.,' Lipsiæ, 1843, p. 93; Henle, 'Pathol. Untersuchungen,' 1840, pp. 37—65; Hannover, Ueber Entophyten auf den Schleimhauten des todten und lebenden Menschen, Müller's 'Archiv fur Anat. u. Phys.,' 1842, p. 281, tab. xv, figs. 1—4; Remak, 'Diagnostische und Pathogenetische Untersuchungen,' Berlin, 1845, ix; 'Pilze der Mundhöhle und des Darm Kanals,' pp. 221—227; Boehm, 'Die Kranken Darmschleimhäute in der Cholera,' Berlin, 1828, p. 57; Vogel, 'Allgem. pathol. Anat.,' Leipzig, 1852, p. 395; Robin, 'Des Fermentations,' Paris, 1847; Gruby, 'Compt. rend. des Séances de l'Acad. royale des Sciences de Paris,' 1814, xviii, p. 586; Ilmoni, 'Foerkandligar vidde Skandinaviske Naturforskarnes tredje Moeteï,' Stockholm, 13—19, 1842, p. 840; Bennett, 'Lectures on Clinical Medicine,' Edinburgh, 1851, p. 213, fig. 79, and p. 222, fig. 102; Robin, 'Histoire naturelle des végétaux Parasites,' Paris, 1853, pp. 322—327; 'Atlas,' tab. ii, fig. 10, tab. iv, figs. 3 and 4, tab. vi, fig. 1.

II. *Merismopœdia Ventriculi* (Meyen). Tab. I, fig. 2.

Class—*Isocarpeæ.*
Sub-class—*Malacophyceæ.*
Tribe— *Palmelleæ.*

Cellulæ globosæ ellipticæ, aut raro polyedricæ, liberæ; plus vel minus discreta, vel in strato plerumque definito aggregata.

Genus—*Merismopœdia.*

Phycoma parvulum non affixum, quadratum, planum; gonidiis (cellulis) quaternatiis, solidis (aquaticæ).

Species—*M. ventriculi.*

Synon.—Genus: *Sarcina.* Species: *S. ventriculi* (Goodsir). *Sarcina* of authors.

Phycoma coriaceum, pellucidum, quadratum prismaticum aut irregulare; 8, 16, 64 *cellulis quadratis quaternatis, nucleatis, leviter æruginosis compositum; diam. cellularum* 0·008 *mm.; nucleorum* 0·002-4 *mm.; strato longit.* 0·030—0·050; *lat.* 0·016—0·020 *mm.*

This is a compound membranous, transparent plant, formed out of cubical, elongated, prismatic, or even irregular masses, which are ordinarily composed of eight, sixteen, or sixty-four cubical cells (*gonidia*).. Each cell is divided on its surface, through slight furrows, into four prominences (*frustula,* Goodsir). The neighbouring cells touch, or barely touch each other, and are usually coloured of a faint red. The internal nucleus has the bright brown colour of the entire mass.

Habitat.—*In ventriculo hominis sani et ægroti aut Leporis cunicul. in fæcibus hominis et imprimis diarrhoicis, in urinæ crassiminibus et pene tabido et abscessum gangrænosorum ex c. pulmonum.*

This plant, which for the host it inhabits appears so injurious, consists generally of cubical prismatic, roundish, or irregular masses of cells, which are square at one end and round at the other, and of which the largest are 0·055-30 mm. long, and 0·020-16 mm. broad. These masses are very consistent, resembling the corium; they are to a certain degree elastic, heavier than water (so that they fall to the bottom in liquids), colourless or slightly brown or reddish, transparent. According to Virchow, they are coloured yellow at first by iodine, and swell up, and are

rendered colourless by the addition of cold sulphuric acid. When sulphuric acid alone is added, they become reddish or brownish from carbonization. According to Hasse, they become brown when first treated with cold sulphuric acid, and afterwards with iodine. They contract somewhat in alcohol, and are not destroyed even by heat, nitric acid, or the caustic alkalies, but their cellular structure gives way. When pressed between two pieces of glass, they give, according to Lebert, a sandy feeling. Towards reagents they behave as the Diatomaceæ, on account of which Lebert attributed to them a siliceous covering. But when treated with muriatic acid, and burned, they yield an ash in which the form of Sarcina can no longer be discovered. They are not destroyed by putrefaction coming on in the fluids in which they are contained. Their structure is very simple; they adhere together sometimes merely through contact, and sometimes through a mucilaginous interstitial mass, which swells up in solutions of the alkalies. The cells measure about 0·008-10 mm., and exhibit under the lower powers of the microscope, cubical blunt edges, but under higher powers the edges are sinuous. With lower powers these edges again appear pointed, but with higher powers they are rounded at the corners. They have in the middle of the surface a slight depression. From this central depression there proceed four linear depressions or furrows, from which originate four roundish projections, which, although they are not to be compared with the corresponding formations in *Diatomaceæ*, have nevertheless been named *"frustula"* by Goodsir. The cells lie generally four, eight, twelve, sixteen, twenty-four, &c., together. Through pressure, they break away, and form smaller masses, resembling the parent-cells, and should they present a kind of envelope, it arises from their coming in contact with the digesting food or mucus.

Every cell, according to Robin, is either composed of an homogeneous mass, free from nuclei, or more frequently of the same mass with four or two or three nuclei. Both kinds of cells are to be seen near one another, according to the observations of Hasse, Kölliker, Müller, Simon, Robin, and Lebert. Robin thinks that those who have not seen these nuclei at all, must have accidentally missed them, or used magnifying powers under 600 diameters. These nuclei, which are from 2 to 4000th, seldom the 6000th of a millimeter in diameter, are cubical, elongated

prismatic, with rounded corners or even almost spherical, refract the light strongly, and contain *nucleoli*. Sometimes nothing is to be seen in the cells but these four nuclei. Virchow, who seems to have examined these bodies carefully, maintained that they were neither nuclei nor protuberances, but that they were depressions from which the furrows proceeded, or a point of crossing from which a new furrow took its origin.

Neither Virchow nor Lebert ever saw this fungus present at the same time with the ferment-fungus, but Lebert saw it at the same time with the *Alga filiformis oris*.

Medium.—The fluid in which these *Algæ* flourish sometimes gives an acid reaction, as, for instance, in the vomited matters in which Wilson discovered acetic, muriatic, and lactic acids. It is less frequently alkaline, but has been found by Virchow in ammoniacal pus.

Method of observation.—The matter containing the plant should be collected in the most convenient manner. Vomited matter should be allowed to rest, and the deposit collected. This should be submitted to the microscope, with a magnifying power of not less than 600 diameters.

Nature and character of this formation.—John Goodsir discovered this organism in 1842, and indicated its vegetable nature, which is held by naturalists at the present day; but Busk and Link regarded the *Sarcina* as an animal belonging to the genus Gonium, and Schlosberger maintained that it was nothing more than decomposed primitive muscular fibre. The views of the first two observers were refuted by the brothers Goodsir, Harry and John; the last was opposed by Virchow, who showed that the cubical portions of Sarcina were much larger than any that could result from the decomposition of the bundles of muscular fibres. He also showed that the muscular fibre entirely disappeared in acetic acid, whilst the Sarcina was only distended, and that muscular fibre disappeared in water, whilst Sarcina remained. With respect to the view that it is a product of the decomposition of the tissue of the animal body resembling fatty degeneration, Virchow remarks that it is insoluble in ether. Hence he arrives at the following results:

1. The Sarcina is no product of decomposition.

2. It stands in no relation to fermentation, or certain other morbid symptoms.

3. But provided its cellular nature be clearly made out, it may be arranged with certain forms of lower plants.

Some writers have regarded it as identical with the ferment-fungus; but as we have already seen, there is no proof of its identity, or of its connection with the process of fermentation.

Lehmann regards it as identical with *Merismopœdia punctata;* Meyen with *Gonium tranquill*, Ehr., and *Aymenellum quadri-duplicatum*, Brébisson. But it is distinguished from these species by its tabular-formed masses, by the nearly double size of its surfaces, and their lying more close to each other.

Robin observes that in the representations of Bennett and O. Funke the nuclei are not given.

Development.—According to Goodsir, this plant is increased singly through division. Frerichs, who observed specimens obtained from a fistula in the stomach of a dog, says that at first the plant appeared in the form of round isolated cells, seldom two together. They were without enlargements, and about 0·005-7 mm. large. At first they were transparent, and exhibited a furrow in the middle, which soon became crossed by another at right angles, each running to the periphery, and dividing the cell into four parts. Each individual was thus divided into four right-angled plates, which were divided from each other through the crossed lines. The most recent case of Sarcina is that reported by Neale, in the 'Medical Times' for July, 1852. In this case there was also found in the vomited matters, the spores of *Penicillum glaucum*, and also through the use of reagents the formation of murexid (by the addition of nitric acid and ammonia), and of crystals similar to uric acid, and the ferment-fungus, which had not been previously observed in this position. Jenner's case ('Med.-Chir. Rev.,' Oct., 1853, p. 329) is less interesting. In this case, Sarcina was found in the fluid of the ventricle of the brain which had stood in an open glass; but whether it was really in the body, or had got into the glass after the removal of the fluid from the body, there was no means of knowing. There had been no vomiting previous to death. Hassall ('Lancet,' April, 1853, p. 338) found the Sarcina in vomited matters, together with starch-granules, the spores of *Penicillum glaucum*, and other dark brown and oval corpuscles, with free lactic and muriatic acids.

Treatment.—This parasite, as already remarked, is mostly met with through vomiting, at least during life this is the only way in which it is discovered. The cause of the vomiting is, however,

usually attributed to some other form of disease of the stomach, and the treatment is directed accordingly. On physiological principles, the treatment must be conducted to meet the two following indications:

1. The removal of the spores through laxatives and emetics.
2. The destruction of the cells, and thereby the prevention of their development.

At present we have no means of carrying out this indication. The so-called *Parasiticida*, copper and corrosive sublimate, which are effective as against the development of fungi generally, are not applicable here, as they can only be applied where the plant affects the surface of the body. The means hitherto proposed effect but little good. Hasse praises nitrate of potash; also silver, but according to Wunderlich, it has proved of no more value than creosote. In recent times, Neale and Hassall have commended the hyposulphite of soda (℈j—ʒss), in an infusion of quassia (℥ss), three times a day. With the first it produced no actual cure, and with the second only a suspension of the disease for five weeks.

Literature.—John and Harry D. S. Goodsir, 'Anatomical and Pathological Observations,' Edinburgh, 1841—1845; Heller, in Griesinger's 'Archiv für Phys. Heilk.,' 1848, part i, and in Heller's 'Archiv für physiol. und pathol. Chemie und Microscopie,' 1852, part i, p. 30; Busk, 'Microscopical Journal,' 1843; Virchow, Sarcina in his and Reinhardt's 'Archiv für pathol. Anatomie Physiol. und Klinischen Medicin,' i, 1847, p. 264; Schlossberger, 'Würtemb. Correspondenzbl.,' 1846, No. 26, and in Vierordt's 'Arch.,' 1846, vi, pp. 747—768; Hasse, in 'Mitth. d. Zur. Naturf. Ges.,' 1847, p. 95; K. Müller, 'Bot. Zeit.,' 1847, April, No. 26; G. W. Simon, 'De Sarcina ventric. Dissert. inaug.,' Halle, 1847; Naegeli, 'Gattungen einzelliger Algen,' &c., Zurich, 1849, p. 2, where the Sarcina is falsely regarded as a fungus; Lehmann, 'Lehrbuch der physiolog. Chemie,' Leipzig, 1850, ii, p. 128 (translated for the Cavendish Society by Dr. G. E. Day, 1851); Bennett, 'Introduction to Clinical Medicine,' Edinburgh, 1853, p. 214, fig. 80; O. Funke, 'Atlas der physiol. Chemie,' tab. vii, fig. 4; Robin, 'Histoire naturelle des végétaux Parasites,' Paris, 1853, pp. 331—345; Atlas, tab. i, fig. 8, and tab. xii, fig. 1.

III. *Leptothrix buccalis.* Tab. I, figs. 3—6.

Class—*Isocarpeæ.*
Sub-class—*Malacophyceæ.*
Tribe—*Gymnospermeæ.*
Order I—*Eremospermeæ.*

Family—*Leptothriceæ : " Trichomata tranquilla tenuissima, continua (vel obsolete articulata). Cellulæ propagatoriæ propriæ nullæ. Filamenta tubulosa, continua, sine articulatione et motu, endochromate confluente, indistincto plena. Cellulæ propagatrices nullæ aut ignotæ."*

Genus—*Leptothrix: Filamenta tenuissima eramosa nec concreta, recta aut interdum curvata.*

Species—*Leptothrix buccalis : " Trichomatibus rigidulis, linearibus rectis vel inflexis, non moniliformibus, achromaticis, extremitatibus obtusis, basi in stromate amorpho granuloso, adhærentibus : long.* 0·020—0·100, *lat.* 0·0005 *mm."*

Habitat: *" In superficie linguæ, intervallis dentium, cavo dentium corruptorum, unde in succos stomachi aut intestinorum (si diarrhœa accedit) descendit."*

Wedl describes this plant as occurring upon the epithelium of the papillæ of the tongue in the form of a dark brownish-yellow granular mass. From these masses are developed very delicate fibrillæ transversely divided, entirely structureless, and about 0·0008 mm. broad. They are not affected by vinegar or weak alkaline solutions. They are of various lengths, and mostly assume a bent position. They commence with a few fibrillæ, and gradually form projecting bundles which are evidently of a vegetable nature. They can be easily procured by scraping the middle of the tongue, and are seldom absent except in the case of clean red tongues, whilst they are most numerous on the upper part of the tongue. Wedl, Kölliker, and Höfle regarded them as Fungi; but Robin describes them as Algæ. He says that this parasite is found accompanied by epithelial cells, and a number of a species of Vibrio. It consists of small semitransparent, finely granular yellowish masses of variable form, and a length of 0·020—0·040 mm., and consist of numerous round, straight filaments, free at one end, and with the other planted in the granular mass. Uuder the highest powers of the microscope small round granules

(spores) can be seen in the space between the filaments. The filaments depend sometimes from a kind of stem, but there is no branching or movement of the filaments, nor are there sporangia or clearly, spores present. The Vibriones are very small, but are always mixed with epithelial cells, mucus- and pus-globules, and molecular particles. Individual filaments are found free in the saliva (Lebert).

The soil on which these plants grow is the decomposing deposits of food which lie between the papillæ of the tongue and their processes.

These parasites may be found in great abundance and very fine on the soft masses of food which collect between the teeth, especially if they are allowed to accumulate for some days. Wedl found them in the molecular masses which collect between the tonsils in a dead body. In the stomach and small intestines they frequently accumulate, and Robin has observed them in the stools of typhus patients.

Closely related to these are certain fibrillose and very numerous corpuscles without any transverse division or branching. They are thicker than the last, and about 0·014 to 0·024 mm. long. They have a great tendency to break up transversely. They are neither soluble in ether nor alcohol, nor are they changed by heat or the caustic alkalies and mineral acids. These are perhaps the filaments found free in the saliva by Lebert. According to Wedl their nature is unknown, and he suggests they may be Vibrios. Their envelopes, according to him, are composed of silicic acid, whilst Bühlmann maintains they contain fluoric acid. This resistance to reagents does not, however, appear to be opposed to their vegetable nature, as we know that many plants contain sufficient silica to resist the action of heat.

These formations were known to Leeuwenhoek, who found them present in forty-seven out of forty-nine healthy persons, so that he regarded them as the result of uncleanliness.

There is hardly any *treatment* to be described. The best thing that can be done is to prevent their growth, by rinsing out the mouth and using a tooth-brush after every meal. The tooth-brush should be used on the inside as well as the outside of the teeth. J. Gutman, in a little work entitled 'The Tooth-brush,' has well observed that in the use of this instrument we should not be satisfied with brushing across the teeth, but should brush up and down from the gums to the crown of the teeth, whereby

the parasites get removed from secret corners in which they are lurking. The tongue should also be cleaned with the brush or the scraper.

Literature.—Ant. Leeuwenhoek, 'Arcana naturæ detecta,' Lugd. Batav., 1722, i, 40, fig. A; Mandl, 'Recherches microscopiques sur la composition du Tartre et des Enduits muqueux,' 'Compt. rend.,' xvii, p. 213; Remak, 'Diagnostiche und pathogenische Untersuchungen,' Berlin, 1845; Bühlmann, Müller's 'Archiv,' 1840, pp. 442—445, tab. xiii, figs. 1—6; Henle, 'Allgemeine Anatomie,' ii; Bouditch, 'American Journal of the Med. Sciences,' April, 1850, p. 362; Robin, l. c., pp. 345—354; 'Atlas,' tab. i, figs. 1, 2; Wedl, 'Grundzüge der patholog. Histologie,' (translated for Sydenham Society by Busk), pp. 746—749.

IV. *Leptomitus urophilus.*

Family—*Leptomiteæ*: "*Algæ cespitosæ, lubricæ, vel adnatæ vel liberæ, ex trichomatibus articulatis, subtilibus achromaticis compositæ.*"

Genus—*Leptomitus*: "*Trichoma articulatum in apicem attenuatum, ramosum; articuli cavi, vaginati. Spermatia* (*Sporidia*) *lateralia, raro interstitialia, epispermio pellucido cincta.*"

Species—*L. urophilus*: *Filis cespitosis, hyalinis, ramosissimis, ramisque patentibus alterne subternis articulatis; articulis diametro æqualibus vel sesquiduplo longioribus.*

Robin: "*Cespes hemisphæricus, gelatinosus, altitudine* 2 *vel* 3 *millim. metiens. Fila primaria e puncto centrali quaquaversus irradiantia; hyalina, a basi ramosissima, vix* 0·0075 *mm. crassa. Rami iterum atque iterum ramosi, ramis patentibus. Ramuli tertii ordinis terni quaternive, secundi, obtusi,* 0·0030 *mm. circiter æquantes, sensim minores evadunt prout apicem versus, ubi ex singulo articulo quandoque constant, observantur. Articuli variæ longitudinis; gonidiis nullis fracti, at spatium orbiculare pellucidum* (*an guttulam oleosam?*) *in centro exhibentes.*"

The nature of this parasite is still doubtful, and Robin expresses his conviction that the genera *Leptomitus* and *Hygrocrocis* are degenerated forms of fungi which cannot fructify because they are withdrawn from the influence of the light. It seems, indeed, more probable that these parasites have some relation to cystic formations, than that they should develope in the urine, as

the name *urophilus* seems to indicate. It also appears to me that the distinction between these formations and the changes which milk-hairs undergo by the morbid collection of air in their interior has not been sufficiently attended to.

Habitat: *In urina morbosa cum filis emissa* (Rayer).

Literature.—'Compt. rendus' et 'Mémoires de la Société de Biologie,' 1849, i, p. 29; Robin, loc. cit., p. 361.

V. *Leptomitus* (?) *Hannoverii.* Tab. I, figs. 7 and 8.

Filamenta recta, tenuia, nunc pellucida, nunc granulos continentia, ramosissima ad unum aut ad utrumque latus; rami non multo tenuiores truncis; extremitates interdum inflatæ.

Habitat: *Hannover invenit speciem in massa pulposa ulcerum œsophagi, et in typho, pneumonia, pleuresia, phthisi, delirio tremente, apoplexia, diabete, gastritide chronica.*

This formation presents itself upon the living body on the tongue and pharynx. It has been described so inaccurately by authors, that Hannover, Mayer, and also Robin, each one of them, takes a different view of this organism. Robin thinks that Hannover has entirely overlooked the spores.

Literature.—Hannover, 'Ueber Entophyten auf den Schleimhäuten des todten und lebenden menschlichen Körpers,' Müller's 'Archiv,' 1842, p. 280, tab. xv, and Valentin's 'Repertorium,' 1843, p. 84; Robin, l. c., pp. 362—364; 'Atlas,' ii, figs. 11, 12.

VI. *Leptomitus* (?) *Epidermidis.* Tab. I, fig. 9.

Gubler, who found this parasite, says that it occurred in a young man who received a wound with a bullet through the right hand. The wound was poulticed, and the skin became white, opaque and wrinkled, as though macerated. On the fifth day there appeared on the back of the hand and of the little finger, white vesicles (like eczema vesicles after poultices), which gradually increased in numbers and size, and produced a slight itching. When scratched they emitted a reddish fluid, but under the microscope they exhibited a number of byssoid filaments, such as occur in "muguet." These filaments were very long, frequently divided across, but were less clearly diaphanous and articulated

than the filaments of "muguet." Partition walls could be clearly seen, especially towards the ends of the primitive filaments, and in the secondary branches. Gubler could not find spores in the inside of the filaments, but only free in the sporidia which floated about in the water used for microscopical examination. The sporidia were elliptical in form, straight or slightly bent, and divided into two cavities by a partition wall. Montagu regards this parasite as a *Leptomitus,* or a cryptogam standing nearly related to it.

Literature.—'Proces verbaux des Séances de la Société Biologie,' Samedi, 24 Janv., 1852; Robin, l. c., pp. 364 and 365; 'Atlas,' x, fig. 1.

VII. *Leptomitus Uteri.*

Lebert, in 1850, found an Alga in uterine mucus, which has since been more accurately described by Robin. It consists—

1. Of naked tubes, which are more or less elongated and branched, and are without partition walls and granulations in their interior.

2. Of tubes a little broader, articulated, and furnished with partition walls of varying length, and sometimes branched, and which are terminated by granulated masses or spores.

3. Of spores which are sometimes formed of ovoid, elongated, granulated cells, with one or two clear drops in their interior, and sometimes of ovoid or spherical cells with prolongations. The last cell of the receptaculum which bears the spores is ordinarily more swollen than the others, and a little granulated.

Lebert thinks that the spores of this Alga might be destroyed by injections into the neck of the uterus.

Literature.—A communication from Lebert to Robin, published in the work of the latter on the 'History of Vegetable Parasites,' pp. 366 and 367; 'Atlas,' v, fig. 1.

VIII. *Leptomitus* (?) *Muci uterini.* Tab. II A, fig. 1.

This alga was found by Wilkinson in a morbid puriform discharge from the uterus of a woman seventy-six years old. It consisted of primary and secondary filaments, the latter of which were from $\frac{1}{4000}$th to $\frac{1}{8000}$th of an inch in diameter. The edges were

colourless. They were of various lengths, and bent and undulated. They were rendered transparent by acetic acid, and were seen to be composed of elongated cells, laid end to end, as in many fresh-water Confervæ. In some of the filaments the cellular structure disappeared, so that they appeared like simple fibres.

The primary filaments were from two to six times larger than the secondary. The broadest were shortest, and terminated at one end bluntly, and at the other with a bundle of six or seven long secondary filaments. The blunt ends of the primary filaments seemed to be adapted to the formation of partition walls and spores. Besides these, Wilkinson observed ovoid or spherical corpuscles, which frequently presented, when treated with acetic acid, a nucleus. On account of the above-noticed bundles of small fibres, Wilkinson called this parasite *Lorum* (wool) *uteri*. This parasite is not injurious to its host. The drawing given by Wilkinson resembles the *Sphæria Robertsii*, of which Robin has given a figure in his tab. xiii, fig. 6.

Literature.—Wilkinson, Some Remarks upon the Development of Epiphytes, with the description of a new vegetable formation found in connection with the human Uterus, 'Lancet,' 1849, p. 448, figs. 1 and 2 B (fig. 2 A′ and A are out of the question, as they appear to be *Cryptococcus cerevisiæ*); Robin, l. c. pp. 367—369.

IX. *Leptomitus* (?) *Oculi.*

Helmbrecht relates the case of a clergyman, forty-two years of age, who came under his care for an inflammation of both eyes, and which was attended with a sudden sanguineous enlargement in the left eye. Warm fomentations and a foot-bath removed the phenomenon, but epiphora and a flashing in the eye remained. By resting the eye this also disappeared, when he suddenly, without any obvious cause, saw figures of a constant form with the left eye, and *muscæ volitantes* in the right. The last got well, but there remained in the field of vision of the left eye a constant form, which moved itself in a definite manner in various directions. After this the patient had a fall from a carriage, when the movements of the figure became more free. Helmbrecht now made a puncture in the lower part of the cornea, to allow of the passage of the body supposed to be loosened by

the fall. In the fluid which came away there was found under the microscope, with a power of 280 diameters, a branched vegetable body, divided into four parts, which consisted of confervoid cylinders and rows of spores. After the operation the patient got quite well.

It was a pity that the spores were thrown away without any attempt to make them germinate, so as to ascertain the nature of this parasite.

Literature.—Helmbrecht, 'Fall einer confervenartigen Afterproduction in der Augenkammer des linken Auges, welche nach der Paracentese glücklich beseitigt wurde, Casper's 'Wochenschrift der Gesammte Heilkunde,' 1842, No. 37, pp. 593—600, and Neuber in the same, No. 53; Robin, l. c., pp. 369—371.

Hannover, in his recent work on the eye (1852), has related a very similar case. A man who had a long time been troubled with figures as of a string of pearls before his eye, had the operation of paracentesis performed on his eye. In the fluid which escaped there was found a branched mass of small cylinders, which were partly filled with globules, and partly covered externally with minute processes, which were without cylindrical walls, and moniliform in shape. The fungus, which occupied the entire of the interior of the eye, was colourless, or of a slight gray colour, and exhibited two principal forms, one consisting of fine fibres, the other of coarse. The contour of the fine fibres was linear and simple, their contents clear and uniform. The broader fibres were crisped, but of a simpler contour, and with granular contents. Other fibres were moniliform, with an irregular contour, and clear uniform or granular contents, and were longer and more numerous than the fine fibres. The coarse fibres were sometimes linear and simple, with clear and glittering homogeneous contents, with small and short branches; sometimes they had an undulating contour, as though they were composed of these compressed globules; glittering fibres reflected the light like drops of oil. Lastly, there were present many free globules (sporidia), from two to three times as large as blood-globules. These bodies refracted the light very strongly, resembled the cells of the ferment-fungus of beer, and had uniform contents without a nucleus. Some of the cells were isolated, whilst others were heaped together. The coarse and fine fibres were found towards the periphery of the eye, whilst the pearl-necklace fibres were in the inside. The innermost masses consisted almost en-

tirely of free sporidia, and some fibres with the appearance of rows of globules.

Hannover says that previous to the establishment of the disease or the destruction of the eye in this case, there must have been the introduction of a spore of the plant through some pervious point in the cornea.

On account of the similarity of this plant to the ferment-alga or fungus, I have introduced it here. Hannover and others believe that these observations are important in relation to the explanation of the very diverse and puzzling forms of scleromata.

X. *Oscillaria Intestini.*

Sub-order—*Tiloblasteæ.* "*Algæ trichomaticæ. Trichomata ex cellularum seriebus composita, aut in substantia communi inclusa, aut in substantia communi, gelinea, matricali, amorpha et continua nidulantia.*"

Family—*Oscillarieæ :* "*Trichomata motu proprio spirali prædita. Propagatio ex cellulis vegetativis; cellulæ spermaticæ propriæ nullæ.*"

Genus—*Oscillaria. Trichomata articulata socialiter crescentia, muco communi, matricali, mollissimo vel subliquido, continuo et amorpho, vel in tubulos utrinque apertos, vaginiformes, liberos contracto, inclusa.*

Species—*Oscillaria Intestini.*

This parasite is composed of a number of elongated filaments, with partition walls which cross each other in all directions. Each of the cells is considerably elongated and contains a quantity of green matter. According to Farre the spores of this alga must have been taken into the intestinal canal by drinking water. He found it enveloped in membranous reddish masses, brought away during an attack of colic in a dyspeptic woman.

Literature.—Arthur Farre, On the minute structure of certain substances expelled from the human intestine, having the ordinary appearance of shreds of lymph, but consisting entirely of filaments of a confervoid type, probably belonging to the genus Oscillatoria, 'Trans. Microscopical Society,' vol. i, p. 92, pl. xi *b*; Robin, l. c., pp. 404, 405.

I have not seen the plate of Farre's *Conferva*, but the species described under the genus *Leptomitus* are only superficially

described, and can hardly be received at present as actual parasites. Although I do not regard them as so unsatisfactory as to set them aside altogether, I must nevertheless express my doubts with others, as for instance Virchow, of the genuine parasitic nature of these plants.[1]

B. Fungi.

Plantæ terrestres, acotyledoneæ; pulverulentæ, flocculosæ, filamentosæ, parenchymatosæ, carnosæ vel coriaceæ, achromaticæ, albæ, nigrescentes, fulvæ, olivaceæ, rubigniosæ, vel rubræ; cellulares; ex cellulis minutissimis, isolatis, catenatis, vel tubulosis continuo-ramulosis (mycelium), vel filamentoso-articulatis, vel prosenchymaticis, vel parenchymaticis formatæ. Sporidia ex singulis cellulis constituta, aut ad extremitatem receptaculi concatenata, vel in superficie inspersa, aut sporangiis inclusa.

The vegetative system is represented by filaments, which are simple at first, but branch out after some time; each of which representing a single oval cell, rarely several cells ranged one close to the other; and lastly there are partition walls in them (*mycelium*). The mycelium changes its appearance according to the position of the filaments which form it. The fungi found on living animals only show most frequently the nematoidal or filamental mycelium (loosely crossed filaments) and the membranous (closely united and mixed filaments which form a kind of membrane more or less solid). According to the amount of moisture or dryness, or the light in which they are developed, the filaments of the mycelium exhibit a different appearance, so much so that the differences and varieties of form which are thus produced were often mistaken for different species, which easily led to confusion when the organs of reproduction were not examined at the same time.

The reproductive system consists of—

1. *Spores* (*sporidia, sporules*), which are generally very numerous in each individual, often quite innumerable. They fall off as fast as they are generated, and are probably reproduced simultaneously in large numbers. The spores lie immediately on the receptaculum, either loose, or fastened on by means of "*basides* and *clinodes*," or inclosed in a spiral organ (*theca, sporangium*), which

[1] See Appendix C.

sometimes lies embedded in a *conceptaculum*, borne by the receptaculum, sometimes not. The spores are generally very small bodies, varying in size, according to the species, from 0·004-5 or some hundredths of a millimetre. Their smallness enables them to penetrate every natural cavity—the folds in the skin of animals, cracks in plants, in short everywhere where dust could get; and, like the latter, they are carried by the wind on to slimy surfaces and deposited there. Their form is generally oval or spherical, sometimes triangular with normal rounded corners, or irregular, and often of a longish oval shape or spindle-like. Their consistency is very great, so much so that they can scarcely be crushed between plates of glass. This firmness facilitates their penetrating the skin. The consistency of spores which are yet between the sporangia is less; they are found to be frequently elastic and pliant, if they are of a longish shape. Spores do not lose their capacity of germinating by drying, if in so doing the temperature is not raised beyond 70° C. (158° Fahr.) They are less dense than water and float on it. Wind and water may therefore spread and carry them far and wide. They vary in colour—gray, brown, yellowish, or, if the light is falling on them, almost colourless. In reflected light they look gray, yellowish or of a white, more or less brilliant. If they reflect the light strongly, they show in the centre a brilliant, usually yellowish spot. As long as they lie in the sporangium, however, they are mostly colourless, and look polished, transparent, or greenish. When very numerous they give to the touch the feeling of fine sand, their surface has a brilliant appearance, and they sometimes possess a peculiar mouldy odour and taste, especially when they fructify and are free. They are apt to produce injurious effects on man when introduced into the body, by way of the food or during respiration.

Chemical reagents act but little on them. Tincture of iodine, when employed alone, colours them of a dark yellowish-brown, like other purely nitrogenous substances. When their cellulose walls are not coloured blue by the action of the iodine, their nitrogenous contents become brown. On treating them with hydrochloric or nitric acid, or, better still, with hot sulphuric acid, before adding tincture of iodine, the nitrogenous part coagulates, contracts, and separates from the sides of the spores, and remains, forming irregular masses in the centre. On applying afterwards tincture of iodine to these parts they become brown,

and the cellulose walls greenish—the complementary colour of the blue of the cellulose and the brown of the tincture of iodine.

The structure of the spores is very simple : all present a cell without a nucleus. The cellulose walls are very thin, yet possess great resisting power. They are covered with a nitrogenous *utriculus,* which encloses a fluid in which granules are suspended, possessing sometimes a whirling motion (Brown's molecular movement). The utriculus may be recognised by the above-mentioned reactions, during which it is torn into rags.

The simplest fungi, like the Torulaceæ, represent isolated cells, or rows of two, three, four, &c., cells, which are very analogous to the spores of many species of fungi. Each cell is the mother of a new similar one, whilst the spores of the higher fungi generate a longish cell which forms the filament of the mycelium.

2. The Receptacle (*receptaculum,* chapeau, *capitulum,* chapiteau) is the organ upon which, directly or indirectly, the spores which have been set free rest. They are held fast by means of "*basides,*" whose "*spicula*" or "*sterigmata*" bear a spore, or by means of "*clinodes.*" When the spores are not free, they are contained in the receptacle or in the sporangia. A great many species form their receptacle of a longish cell scarcely differing from the filaments (for instance, the *Oidium albicans*), or of a row of cells, when the last cell displays the presence of spores on its surface by a slight swelling, and represents the receptacle, whilst the preceding, which are for the most part broader than the filaments, represent the stem (*pediculus, caulis, pedunculus, truncus, petiolus, stipes*), that is, the more or less capacious bearer of the receptacle.

When the receptacle is dry, membranous, and filled with the spores, it is called *peridium*; when it is horny and surrounds the spores, either in their free state or contained in *thecæ, perithecium* or *peritheque.* When the receptacle is of a globular or disc-like shape, the conceptacle, a peculiar, globular or oval, horny or fleshy, hollow organ which encloses the sporangia of the *thecæ,* and which opens by means of bursting its sides or through a pore at the end, is observed. The *theca* = *sporangium* is a distinct, globular, oval, or longish vesicle, capable of isolation, filled with spores, and which is sometimes placed on the surface of the receptacle, and sometimes in a conceptacle.

The *Basides* are small prominences on the surface of the receptacle, consisting mostly of a round, oval, or longish cell, with one or more small cells at its point in the shape of a conical point (*spicula, sterigmata*), at the end of which a single free and uncovered spore is found.

The *Clinode* is an accessory body composed of very small, longish cells, either simple or branching off, with a free spore at its end. It forms uninterrupted filaments of various length, or is provided with partition walls which originate in the cells, which represent the parenchyma of the receptacle.

Cystides and Paraphyses.—There is frequently to be seen on the receptacle or between or along the sides of the sporangia, *basides* and *clinodes,* prominent globular or oval cells, sometimes in the shape of a thread, simple or branched pointed, blunt or swollen at their free end. These cells in the Pezizæ and Sphæriæ are called "*paraphyses,*" and those in the Agariceæ and Boletæ "*cystides.*" They are sometimes, though wrongly, called *antheridia,* since they have never been found to contain spermatozooids like the antheridia of the *Algæ.* They are of little importance, and little is known about them. They may be considered as accessory vegetative organs connected with the reproductive system. Perhaps they are connected with the simple or branched filaments formed by articulated cells, which are found along the sides of the terminal sporangium in species which are still more simple than the *Sphæriæ.*

Up to the present time thirteen species, or, if the nail-fungus is to be considered as a separate species, fourteen species of fungi are known to attack the human body. They may be divided into three groups.

Trichophytæ.

I. *Trichophyton tonsurans.* Tab. II, figs. 1, 2.

Division I—*Arthrosporei.*

Receptacula filamentosa, simplicia aut ramosa, clausa, fere nulla aut nulla. Spori in ordine dispositi; terminales persistentes aut caduci.

Tribe—*Torulacei: Recept. nullum, aut fere nullum, vel floccosum. Sporidia continua.*

Genus—*Trichophytum* (Malmsten).

Vegetabile unice ex sporis formatum. Spori rotundi aut ovales, pellucidi, sine colore et in superficie læves; diameter 0·003—6—8 *mm.*

Habitat: *In interna parte radicis capillorum, ubi spori firmant acervum rotundum. Ex sporis exeunt filamenta articulata, quæ sunt spori, in filamentis moniliformibus positi, et, dum sese evolvunt, substantiam capilli penetrantes, eumque per totam longitudinem peragrantes.*

Species—*Trichophyton tonsurans.*

Synon.: *Trichomyces tonsurans*; = *Epiphytes* = *Mycoderma* = *Trichomaphytes plicæ poloniæ*; = Champignon des cheveux dans l'Herpes tonsurans; = Champ. voisin de celui de la teigne, by Lebert; = Champ. de la teigne fondante, du *Porrigo scutulata* ou *Herpes tonsurans*; = *Achorion Lebertii*; = Cryptogame de la teigne tondante ou de la Rhizo-phyto-alopécie. *Porrigo circinnata* and *Porrigo tonsoria* are synonyms for the disease accompanying this fungus.

Habitat: *Unice in interna parte radicis capillorum humanorum, sed non in eorum superficie. Post capillorum rupturam invenitur in crustis epidermidis et sebaceis capitis pileati.*

The filaments placed in rows in which the spores originate have undulated edges, and show in their interior, at small intervals, the round spores, rarely so long as to imitate the filaments, and peculiar to the *Cryptogamia.* These spores are round, transparent, half as large as blood-corpuscles, 0·003—7—0·0010 mm. long and 0·003—4 broad. Many have in their interior a distinct spot or vaguely defined nucleus; many, when they are long in shape, appear to have a constriction in the middle. There are no partition walls, although it appears as if they existed, when the spores are very close together.

The medium in which this fungus is found is not, as it might appear, the space between the cells of the epidermis, where they are never met with, but in the substance of the root of the hair itself, though it remains yet very doubtful whether this fungus thrives only in diseased or also in healthy hair, after its spores have once penetrated the substance of the hair. The spores form at first a round heap, which spreads more or less upwards in a straight line with the longitudinal axis of the hair-mass, which is thus enlarged till it brings on a state of disease known under the name of *tinea* or *herpes tonsurans.* The fungus goes on growing with the hair, and when it has grown 2 or 3 mm.

above the edge of the skin together with the hair, the latter breaks off.

The cylinder of the hair is quite filled with spores, and its substance is entirely indiscernible. The growth of the plant goes on quickly; but it is inside the substance of the hair. In the scales which cover the head itself the fungus is never found.

Effects of the parasite.—Small rugged elevations on round spots are observed, chiefly on the part of the head which is covered with hair, and which give to it the appearance of the seal-skin. The hairs are broken off at 1—2‴ above the edge of the epidermis in a regular manner, and baldness is the inevitable result. The skin is dry in such patches, firmer and more contracted than on the surrounding parts. Small rough inequalities, similar to those on the skin of a goose, may be observed and felt. The colour of the skin is a little bluish. On scratching, the skin becomes covered with a white dust resembling fine bran. The disease shows itself at first in a very small spot in the middle of the circle which it afterwards forms, and grows from thence eccentrically. The same takes place when the patches are at last uniting into one. Sometimes this disease spreads over the whole hair of the body, and attacks even the nails.

The nature of the disease is well illustrated by the case observed and communicated by Malmsten:

A mother observed, in November, 1843, when she was combing the hair of her boy, three years old, a little to the right of the large fontanel, a small hairless spot covered with white scales, which became larger, in spite of carefully combing off the scales. In February, 1844, this spot was $1\frac{1}{3}$ inch in diameter, and was covered with grayish-white little scales, from which issued and grew up a number of small smooth hairs, 2‴ in length, and quite lustreless. The spot was dry, rough, and grayish. On scratching off the scales the skin was found to be not in the least injured, and looked healthy all around. At a short distance a similar bald spot was seen, 2‴ in length, from which the whole of the hair had not yet fallen off, although some of it looked as if cracked off. When the hair had been allowed to grow for some time, some became bristling, whilst the rest remained lying smoothly on the head and was easily pulled out. Every hair, however, was bent, at the height of 2‴ above the skin, into an angle. On the 1st of July the spot had increased to 2″,

the second was $\frac{1}{2}''$ in diameter; the many small scaly spots had likewise grown larger. When the remainder of the hair, 1—2''' in length and covering the scales, was plucked out and examined under the microscope, these fragments of hair were seen, when enlarged only 300 times, to be filled with spores between the hair-fibres. The root of the hair presented a mouldy appearance. The spores lie sometimes in the form of a necklace; sometimes they represent articulated branches. When the hair is torn out, fresh hair grows after some days, showing, however, the same tendency to mould. Fragments of hair are seen in the scales on the bald patches, bent and twisted in all directions, and the spaces between the fibres charged, as if with spores. It is probable that the lead-gray colour of these fragments of hair is derived from their being mingled with scales.

On considering the properties of the diseased hair more closely, it is found that the root of the hair is at first, when it is the exclusive seat of the disease, opaque, dwindling away, and almost always bent, whilst the rest of the hair is quite healthy. In proportion as the fungus developes itself in the substance of the hair, the latter becomes thicker and coarser, grayish, and opaque, loses its elasticity, becomes soft, and breaks, showing an uneven filamentous fracture. The fractured pieces are full of fungi, and remain covered with scales. If the hair breaks off underneath the skin, the end of the capillary canal becomes stopped up with scales and fat, which harden, and are at last raised by the hair; this has sometimes been erroneously mistaken for an abscess. With the decrease in the development of the parasite, the hair becomes less gray, firmer, thinner, and finally normal. If the head is kept clean, only a slight redness of the skin, or small pustules or crusts are observed, which, however, rarely degenerate into impetigo.

Want of cleanliness of the head makes the skin look like the flesh of a hen or a shark. If no complication occurs at first, only an increased formation of scales takes place, together with the presence of fragments of hair, as in pityriasis, unaccompanied by a falling off of the hair; on the contrary, the latter generally grows faster. The disease frequently attacks children who are in good health. Sometimes the growth of the hair is seen to be less strong before the breaking out of the disease; the hair is dry, and from this it may be inferred that a certain amount of disease of the hair is necessary to the growth of the fungus.

Unfortunately, we know little or nothing of the state of the fluids, whether in all, or only in some who are scrofulous and the like, they are favorable to the development of the parasites. *Tinea tonsurans* is sometimes primary, and sometimes follows *herpes circinatus*, and seizes at once one or several parts of the head covered with hair, usually the back of the head first, but also other parts of it. If the disease succeeds herpes, it manifests itself at first in the centre of the herpetic rings, where a small tuft of hair becomes paler, reddish, and lighter than the neighbouring hair, and the skin below it a little embossed and covered with epidermic scales, from whence the disease spreads rapidly over the adjoining hair, and forms patches of 1—2 centimetres in diameter. Here and there may be seen among the broken hair of these spots some uninjured hairs. The diseased places are, moreover, covered with spots of white scales, which have a velvet-like appearance, and form sheaths round the broken hairs. Gradually these isolated patches, which represent irregular or circular plains, deprived of their hair, run together into one. If the broken hairs of such a patch are seized with a pair of pincers, they break off with great facility quite close to their point of insertion. Generally this *tinea* is less frequently followed by lasting alopecia than the *favus*.

Bazin thinks he has found this fungus also on animals. He mentions a gens-d'arme who had herpetic patches on the palmary surface of the right fore-part of the arm, one of which had lost its hairs, and for which the man could only account by having been infected with tetters, together with five or six comrades, whilst cleaning horses which were infected with the disease; which statement Bazin found to be true on examining the horses. He found, indeed, that the hair was broken off in these places; and, moreover, as in *herpes tonsurans*, a whitish, squamose, scaly secretion perforated with hair. Deffis and Bazin found under the microscope a formation analogous to the above-mentioned fungus, with the exception that the spores and tubes were much smaller.

These microscopic discoveries explain not only the pertinacity of the disease, since it is well known that the lowest plants develop themselves most intensely and rapidly in a favorable medium, but also its contagious character which is no longer doubtful. The fungus itself is the sole cause of these changes of the hair and of the secondary irritation and con-

gestion of the skin which cause exudation, an accelerated formation of the epidermis, scaling off and production of crusts, because the swollen hair exerts pressure on the skin.

Treatment.—The brothers Mahon cured, in from eight to ten months, the disease, with the remedies employed in favus, and which will therefore be mentioned hereafter.

Cazenave warns us against the use of very powerful local means, recommending washing with solution of borax, and anointing with tar and citron, tannin, liver of sulphur, &c.; and he states that he cured the disease in six, eight, and twelve months, and restored the hair in every case.

Neither the brothers Mahon nor Cazenave begin their treatment with epilation, and the disease may be cured, as Bazin assures us, solely by the above remedies, but only very slowly.

According to Bazin, epilation ought to succeed most wonderfully with successive parasiticidal washings; but, unfortunately, the hair will break off at the slightest touch for the purpose of epilation, and only a few retain their roots. It is easy at the very outset to arrest the progress of the disease by depriving every little patch of its hair, and washing with a solution of corrosive sublimate (two grammes are dissolved in alcohol, and 500 grammes of distilled water added). Acetate of copper and other strong local remedies irritate the skin too much, and accelerate the growth of the fungus enormously. The cure is rapid. If, however, circular, scaly patches, with broken hair in white sheaths, slate-coloured skin, and bristly follicles exist, then the cure becomes tedious, because the hair can only be removed partially and very imperfectly. The eccentric spreading of the disease may be very much restricted by freeing the patches from scales and broken hair, and tearing out, all around, every hair of suspicious look and colour, and applying the above-mentioned lotion. The lotion must, however, be continued for several days, and the patches, together with the hair, treated with an ointment of from thirty to fifty centigrammes of iodide of sulphur to thirty grammes of lard. As soon as the hair grows again over the diseased places they must be removed afresh. The lotion with corrosive sublimate is to be continued as long as the parts covered with hair are no longer swollen, or until they have lost their slate colour, and the root comes out on endeavouring to draw out the hair. This method requires from three to four months, rarely more.

The *principal problem* which the treatment has to solve is, the securing good means of epilation. If such were once found, sublimate or tar would remove the disease in a few weeks.

We pass over Malmsten's treatment, since he does not mention rational epilation, and thought he could succeed by merely lotions and combing. Celsus mentions that some writers recommend the removal of the diseased places, and others the burning them out. I think that this treatment is, *à priori*, more rational than the various ointments which have been proposed, although modern medicine would repudiate them as being too cruel.

History.—Malmsten was the first to describe this fungus, and to communicate his observations to Gruby, who seems to have discovered it almost at the same time. At all events, Robin is in error when he speaks of Gruby's discoveries as having been lately confirmed by Malmsten. The latter had, in his first edition, described a peculiar vegetable, quite distinct from *Trichophyton;* he has, however, abandoned this view since. Lebert recognised this fungus likewise. Malherbe, as well as Cazenave and Letenneur, who had himself been affected with this disease, still deny the existence of the fungus.

Bazin, who knows the fungus very well, though he mistakes spores for molecular granules, has introduced a nomenclature which might easily mislead the student, because the word "decalvans" appears twice in it. He divides the disease into *Tinea favosa, tonsurans, sycosa* (*Mentagrum,* autorum), *achromatosa* (*Porrigo decalvans,* seu *Vitiligo* of the skin covered with hair), and *decalvans* = *Alcpecia idiopathica.*

I can confirm Malmsten's statements. Professor H. E. Richter was kind enough to let me have three hairs which he had collected in Cazenave's 'Clinic' from a man who suffered from "Herpes tonsurans." The microscopic examination completely agrees with Malmsten's description. Robin says, moreover, that the fungus in question and Günsburg's fungus in *Plica polonica* are identical. I am, however, inclined to believe that they must be separated, and I shall therefore treat separately of this fungus.

IIa.—Species—*Trichophyton* = *Trychomaphytes* = *Mycoderma* (Günsburg) *Plicæ polonicæ*. (Tab. II, B, figs. 3—6.)

After Günsburg had, in 1843, found a plant in the medullary channel of the hair of a person suffering from the *plica polonica* Johann Müller, and afterwards Münter, Baum, Simon, Hessling, Skoda, and Fr. Müller, who could not again find the fungus, were of opinion that the discovery had been accidental.

Hebra saw, in one case, as Wedl tells us, on and between the hair of a queue, an immense number of these parasites; but he also, like most modern writers, thinks that the fungus is no pathognomonic sign of this disease, but a mere accidental *compagnon* of it; and he places the discovered fungus accordingly with those of Walther, which will be described hereafter.

Günsburg seems to entertain still the same view with regard to this fungus. He says in a letter that the fungi are found between the root and the hair, in the marrow of the hair, and underneath the epithelial covering of the hair, which causes them to swell and to split.

It is clear from a comparison of Malmsten's parasites and those of Günsburg, that the nature of their growth, and, moreover, the effect on the hair itself, is quite different in the two species, and we can therefore see no reason why they should be made one.

The parasite itself forms (according to Günsburg) articulated filaments, though rarely occurring, and showing no inter-cellular spaces in its interior. The spores are very numerous, round or oval, with a smooth surface sometimes articulated by umbilical spots. The cells are for the most part isolated, sometimes grouped together, and sometimes fastened to a very fine fibrous hypothallus. Iodine dissolves its structure completely, vinegar and caustic potash (kali causticum) do not alter it. The spores measure 0·002—5 mm., and contain point-like molecular granules, and rarely distinct nuclei.

The changes in the hair produced by this parasite consist, according to Günsburg, in the thickening of the root of the hair, a spindle-like enlargement of the longitudinal cylinder of the channel of the hair, through the constant piling up of new masses of fungi in it, in the splitting and parting of single hair

fibres, which gives at last to the hair the appearance of a brush or of a hedgehog's skin in the opening of the hair in some places, through which the spores pass, in the condensation of the hair epithelium, the disappearance of many of the cylinders of hair, and the adhesion of tufts of hair by means of new formations.

The peculiar adhesive mass consists of a great many large epithelial cells, with many small granular bodies resembling the exudation corpuscles of inflammation, of thinned hair whose sheath is covered with spores, in some places of a few epithelial cells, often of the "*Glandulæ sebaceæ,*" and of the parasite which rarely rises above this sheath. The mass is brownish, adhesive, soft, and binds the hair together in bundles, sometimes it dries up in some places, and becomes then of various shapes and sizes. Hebra and Wedl have made similar observations, though they never found spores in the interior of the hair-canals, but masses of parasitical plants on and between the plicated hair. Everywhere on the adherent mass there could be discerned round spores, with a distinct nucleus measuring 0·003—7 mil. in diameter. They formed groups on the periphery of the hair, and nestled in the spindle-like split-up cells of the hair. Very rarely the thallus-filaments are found in the shape of square cells placed in a line. The hair itself was brittle and split up.

Von Walther's experiments on inoculation of the plica polonica were unsuccessful; Beschorner, however, thinks he succeeded.

II*b*.—Species—*Trichophyton sporuloides.*

Von Walther, of Kiew, Russia, stated in 1844 that he had found, in a case of plica polonica, by means of the microscope, a hoar-frost-like covering on all the hairs, which seemed partly to scale off, as well as dirt, insects, epidermal scales, feathers, especially linen threads from the plicated spots, together with small shriveled-up globules on the hair, and other accidental impurities. Skoda also saw many lice in it, and Von Hessling three mites which were not yet known, which, however, he does not think are peculiar to *plica polonica* (see *Acari* in Animal Parasites).

When the quite fresh soft mass from the plica polonica was examined in which healthy hairs were left, it was found to be no

longer liquid, but pultaceous, especially at the points of the plicated tufts. Water turned it milky.

When magnified 400 times, this mass consists of innumerable round or regularly oval little bodies, which refract light strongly; they are 0·013‴ long, and the smallest even shows a dot or spot in its body, containing two little vesicles, one placed inside the other. The one lies in the enclosure of the other, and rises out of the latter a little. The more developed forms lie close to the skin of the head. The form of the exterior vesicle is a depressed round or oval. Both vesicles are transparent, like a drop of clear water. On adding water a molecular motion is observed, which is at once destroyed by corrosive sublimate, which causes the vesicles to shrink. By drying, the vesicles may be obtained in groups of small heaps around the hair, hanging together without adhering directly together. They grow distinctly, and the ventral vesicle is perhaps only the germ to a new molecule. Many vesicles contain 2—3 smaller vesicles. If there are 3, they are found to lie on the longitudinal axis; if only 2, at the two poles of the ellipse. The larger ones show no molecular motion. They *never* range themselves side by side, nor do they sprout out cells like the ferment-fungus, from which they also differ in size and their relation to light. These granules form with the hair the principal part of these masses, and are even found in dry ones, though they are shrivelled up. According to Walther they are independent vegetable formations. The hair-bulbs and follicles were always healthy. The fungus could not be transferred by inoculation. It is not met with in the inner part of the hair. It is to be regretted that Von Walther does not illustrate his views by drawings.

Appendix.—I may be permitted to add here a few words more concerning the plica polonica which do not directly bear on the subject, and yet may be found worthy of the attention of the medical man. Von Studzieniski, in a work of which I shall have more to say further on, has with a certain patriotic indignation about the insinuation of the little amount of cleanliness commonly attributed to his countrymen, tested the views on the nature of the *plica polonica, lues plicosa,* or *lues trichomatica,* and asserts, that he has come to the final result, that the disease is constitutional, standing in close connection with the normal process of cornification of the body, and representing merely an exaggerated activity of this process. He carries out this theory,

which had before been proposed by others (Von Walther), with much energy, and compares the mass which exudes during the adhesive process and the changes in the hair itself, to the processes which we observe going on in the feathers of birds during their falling off and restoration in consequence of moulting. I am sorry to say that the results he has arrived at are little calculated to carry conviction fit to bribe the rational practitioner, however much Herr von Studzieniski may appeal to the feelings of practical men in the words of his preface, and concluding phrase: "This book," he says, "belongs to the practitioner." Medical men are not made expert by mere theories, however plausible, but by results borne out by experiment, and made probable by exact chemical or microscopic researches, and they must always look with suspicion upon a theory where the variations in the action of nervous polarity play a principal part. No experiments are to be found in the book, though it must be admitted that it contains much to interest and to invite to future rational researches. When Herr von Studzieniski mentions further the following diseases as related to plica polonica, viz., Pellagra (in which the formation of scales predominates), the Asturian Rose (*Lepra asturiensis*, in which the formation of scales prevails), both seated in the horny tissues where hair is found; and next Ichthyosis, which, according to Rosenbaum, is the exudation of the blastema of the hair in a shapeless state on the surface of the head, and which spares the hairless palm of the hand and sole of the foot; and further, the Cornua cutanea, or cutaneous horns, which are, according to Rosenbaum, hypertrophied hair and hair germs, and lastly the Scarlievo: we can but call the author's theory to some extent ingenious. It is true that the latter epithet could scarcely be applied to the opinion, "that even scirrhus is a disease of the moulting process." It is, however, incomprehensible, that in such a work the parasitical nature of the plica is passed over without the slightest notice being taken of it, or any investigation of this view. Herr von Studzieniski goes even so far as not to mention at all Günzburg's name either in his text or in his literary appendix. Historical interest is attached to the evidence, that the plica polonica was brought to Pakutia, fifty years earlier than to Poland, by the people who fled before the Mongolian Tartars, and were called Koltún, a name said to be a nickname in these countries to the present day. The disease did not at first appear

along the Vistula, nor did it follow its watercourse, but is reported to have followed the rivers Pruth, Dnieper, and Niemen; and, as a general rule, to have shown itself more along the mountain ridges than along the course of rivers. The disease is further stated to have been known to the ancients, and the heads of the Gorgons and of Medusa are said to have been mere mythical representations of this form of disease. The Cimbrians were described by Roman writers as a people with similar medusa heads (that is, infected with plica polonica), and it is generally thought that, at an early period, the degenerated plica polonica "Sellentost" was found on the shores of the Elbe. Plica polonica is recorded also to have prevailed in the Alps and on the Weser long before it showed itself in Poland; and was found, moreover, in Moravia, Hungary, Carniola, Ceylon, Paris, France, England, and American India, and it appears therefore improper to give to this disease the name plica polonica.

The plica polonica was always believed to exist only on men and animals covered with hair; Von Studzieniski describes, however, an interesting case of this disease on a pair of turtledoves. Von Walther noticed that the blood of persons infected with plica polonica when heated to 30° (?) gives off sometimes a peculiar odour of plica, and that the plicous exudation, not merely on the skin of the head, but on the whole body, issues through the skin, so that the perspiration of such sick persons, who are treated according to Priessnitz's method, is said to be milky and smells like plica. Von Walther observes, moreover, that the matter of plica not only blights the living hair, but also the periwigs and other tufts of hair placed on the body at the period of the eruption of the exudation.

Literature ad I.—Malmsten, translated in Müller's 'Archiv,' by Creplin, 1848, p. 1, table I, figs. 1—3; Gruby, 'Comptes rendues de Paris,' 1844, xviii, p. 583; Cazenave, 'Annales des Maladies de la Peau et de la Syphilis,' 1848; Malherbe, 'Etudes cliniques sur l'Herpes tonsurans,' Nantes, 1852, p. 10, with notes of Létenneur; Létenneur, 'Reflexions sur l'Herpes tonsur.,' Nantes, 1852, p. 17; Bazin, 'Recherches sur la nature et traitement des Teignes,' Paris, 1853, p. 68, tab. II, figs. 2 and 4; Robin, 10, pp. 408—424, tab. II, figs. 7—9.

Literature ad II*a*.—Günsburg, Müller's 'Archiv,' 1843, 1844, and 'Comptes rendus des Séances de l'Académie Royal des Sciences de Paris,' 1843, t. xvii, p. 250; Vogel, 'Allgem.

pathol. Anatomie;' Münter, Müller's 'Archiv,' 1845, p. 42, note; Baum, in a note to Hönerkopf's Dissertation 'De aphtharum vegetabili natura ac diagnosi,' 1847; Wedl's 'Elements of pathol. Histology,' 1854, p. 744; Felix *v.* Studzieniski, on 'Cornification and lues cornificatoria = plica polonica,' 1854, where the richest literature on this subject is found.

Literature ad II*b*.—Von Walther, in Müller's 'Archiv,' 1844, pp. 411—419.

Robin added to the Trychophytæ the fungus which Lebert found in the scabs of an atonic ulcer of the leg. He describes it thus:

III. Species—*Trichophyton* (?) *ulcerum* = Champignon des ulcères. Tab. II, B, fig. 7.

The scabs showed here and there dry yellow spots, of about 1—2 mm. in circumference, and looked like mould. The fungus consisted of round or slightly elliptical spores, 0·005—0·010 mm. large, with nuclei of 0·002 mm. In some a double enveloping membrane could be recognised. There were also other spores, from 0·010—0·015 mm. long, and full of small globules. The former joined, and formed threads like strings of pearls, some of which were branched. Every transition from the simple globules to the threads and branches could be made out. I cannot see why this fungus is placed here, but am not inclined to find it another place.

Literature.—Lebert, 'Physiologie pathologique,' Paris, 1848, ii, 484—85, and Atlas XXII, fig. 7. Robin, I, c. 425—426.

Microsporæ.

Genus—*Microsporon* (Gruby).

Filamenta undulata, directionem capillorum secuta; transparentia, 0·002-3 *mm. lata, sine granulationibus, interdum bifurcata sub angulo* 30—40°. *Filamenta et rami internum stratum, spori externum formantes. Spori propinquissimi, plerumque rotundi, interdum ovales; omnes transparentes, sine granulationibus. Filamenta* (= *trichomata*) *totius ordinis sunt ramosa, sine articulationibus et granulationibus, sporos tamen parantia.*

IV. *Microsporon Audouini.*

Species—*Audouini* (Gruby) = Champignon de la Teigne achromateuse, decalvante, du Porrigo decalvans; *Trichophyton aut Trichomyces decalvans.*

Signa generis. Spori rotundi 0·001-5 *mm.; ovales* 0·002-8 *mm., aquâ intumescentes, filamenta et rami breves.*

The distinctive character of *Trichophyton tonsurans* consists in its numerous curved undulated branches, having generally smaller spores, in the constant absence of granules in the interior, in the spores adhering to the filaments and branches, and in its seat; for whilst *Trichophyton tonsurans* is developed in the root of the hair, *Microsporon Audouini* forms a tube around each hair, of the thickness of 0·015 mm., and surrounds the hair outside of the follicle.

Habitat.—*In superficie capillorum hominis, qui folliculum reliquerunt, et usque ad altitudinem trium Millimetrorum supra cutis superficiem ascendit.*

The filaments run parallel with the stripes on the hair; the branches have the same diameter as the filaments; the former bear the spores. It is not yet known whether the germation of the *Microsporon* requires at first a sort of exudation, or whether the spores are able to develop themselves everywhere merely under the influence of the epithelia and scales, and at the common temperature of the human body. Its reproduction is owing to a segmentation of the points of the filaments; its growth is extraordinarily rapid, for, in a few days, the parasites are found to cover a space of 3—4 centimetres. Its development begins at the outside of the hair, 1—2 mm. distant from the epidermis. The hair becomes less transparent, is 0·030-40 mm. thick, and very finely granulated, till it breaks at last. If the hair has become gray from its root, it breaks off about a week after at the spot where the sheath of the plant begins, and is followed by baldness. The hair-epithelium likewise falls off. The thickest hair resists longest. Around the follicles masses of the fungus heap up, from $\frac{1}{4}$—$\frac{1}{2}$ mm. in diameter, which have falsely been taken for pustules, or secretion of the "Glandulæ sebaceæ." They are, however, una companied by inflammation, hypertrophy of the skin, pimples, or pustules. This fungus is

the cause of "Porrigo decalvans;" no matter whether the hair breaks off at last in consequence of the interrupted nourishment, or because the elements necessary for the development of the hair are absorbed by the fungus. The light gray crusts which cover the places which have been deprived of their hair consist of the parasite mixed with a certain quantity of epithelial cells. Its contagious nature is explained by these facts, and the contagion of "Porrigo decalvans," is nothing more nor less than the spores of *Microsporon Audouini.*

Gruby discovered this fungus in 1843; Robin found it on a child; Cazenave denies it, and regards it as the result of an optical deception. Bazin found the disease everywhere on bodies covered with hair, and recommends epilation and washing with corrosive sublimate, acetate of copper, or the preparations of tar. If epilation is resorted to, it is necessary to seize the hair below the diseased spot, as far as possible, at the edge of the skin.

Droste lately noticed in the 'Deutschen Klinik,' 1854, No. 39, a case of porrigo, described in English journals, of a general absence of every hair of the body, with the exception of some hair on the back part of the ear. If the cure of this case was successful, it was, no doubt, nature's work, and not procured by the above-mentioned remedies. The disease disappeared when all the parts subject to this disease had disappeared, that is, when every hair had fallen off. This general and rapid epilation, caused naturally, remains, however, very remarkable. It is much to be regretted, and must be repeated over again, that similar cases are lost for exact science, as long as the microscope is not more frequently employed in the examination of skin-diseases. It is here more especially, where its *practical* use would become most evident, and where the labour employed on it would soon find its ample reward. I am, therefore, unable to decide whether the case of which Droste speaks exhibited this class of fungi.

Literature.—Gruby, 'Compt. rend.,' &c., 1843, xvii, p. 301, and 1844, p. 585; Cazenave, 'Traité des Maladies du Cuir chevelu,' 1850, p. 197; Bazin, 1 c., 1853, p. 40; Malmsten, Müller's 'Archiv,' 1848, p. 7; Robin, l. c., p. 426—427.

V. Species—*Microsporon mentagrophytes.* Tab. III, figs. 1, 2, 3 = Cryptogames de la mentagre, Mentagrophyte = Champignons de la mentagre.

The spores, which are in countless numbers, hang with one part on the inner surface of the sheath of the hair, and the other on the hair itself; they are round and very small. The filaments or stalks are granulated inside, and divide themselves at an angle of 40 to 80°, in the shape of a fork. The branches are annulated.

Habitat.—In the follicle of the hair of the beard, more especially of the chin, the upper-lip, and cheek, and, according to Bazin, also in the tufts of hair of the skin in general.

This fungus is distinguished from the *Microsporon Audouini* by larger filaments, branches, and spores, and by its seat. It also penetrates into the follicle of the hair to its very root, between the latter and the wall of the follicles. It settles neither in the substance of the hair which lies in the follicle, like *Trichophyton tonsurans,* nor around the part which is exposed to the air close to the skin, like *Microsporon Audouini.* Thus *M. mentagrophytes* forms, according to Gruby, a kind of vegetable sheath surrounding and protecting that part of the hair which is imbedded in the skin, and whose spores are never produced above the surface of the skin. All the diseased parts of the hair are covered with white, gray, and yellowish scales, from 2—6 mm. in breadth and 3—8 mm. in length; they are a little convex in the middle, forming angles a little depressed at the edge, and penetrated in all places with hair. They are attached only slightly to the skin underneath but firmly to the hair, and composed merely of epidermis. The parasite begins to grow between the epithelium of the follicle of the hair and rises along the hair till the latter becomes exposed to the air. The epithelial cells themselves change neither their transparency nor their shape, but only their connection with one another which becomes loosened. The parasite is found either primarily or secondarily on the simple mentagra eczema or impetigo of the lips and nostrils. There exists always, according to Bazin, at first a primary change in the physical quality of the hair which is too often overlooked. The eruption at first is either scattered or confluent; some isolated

pustules are most frequently seen here and there on the moustache or whiskers, which grow and suppurate a little, and the evil seems to have subsided for a time. At last these pustules get closer together and form groups, though each single hair is attacked individually. The eruption is preceded by a burning sensation, pain, and stiffness of the skin, which becomes red and swells. Near the insertion of the hair small pointed, whitish, or slightly yellowish pustules arise, which increase after the lapse of a few days. In some the pustules are scratched open with the nails, whilst in others the matter recedes and dries up in the interior of the pustule. Small yellowish crusts, most frequently isolated, cover then the prominences of the follicle, or a single firm adherent crust is formed which turns brownish or blackish in the course of time. If the inflammation of the follicle does not go on to suppuration, small, hardened, reddish, or brownish crusts, rather papulous than pustulous, and covered with epidermidal scales, are found. The inflammation spreads sometimes to other parts of the skin, as, for instance, to the sebaceous follicles, and swellings as large as a cherry (tubercles) are seen, especially on the lips and chin. The fungus spreads soon and very rapidly from the upper lip; sometimes it remains restricted to the line parting the moustache. The action of emollients and resolvents helps to reduce the inflammation, and the eruption ceases for a time, but only in order to break out with more virulence and to spread further. The disease may thus last for years with alternating changes for better or worse. When it has once become chronic a fungous state of the follicles, which bleed at the slightest touch, comes on, and a badly-smelling, sanious matter is discharged, a thorough change of the hair takes place, which becomes yellowish, ash-gray, whitish, and atrophied, and falls off spontaneously. It may even lead to a permanent alopæcia. There is no doubt that the mentagrum of Martial (Epigramm., lib. xi, 98) and the pudendagrum of Pliny, with its formation of little knots and tubercles, was nothing more than the consequence of the *Microsporon mentagrophytes,* which Roman "libertines" called *Cunnilingi* and *Basiatores,* and which was carried from the chin to the genitals, and from the genitals again to the chin of a third person.

Treatment.—Bazin considers that mentagra renders an immediate removal of the hair necessary, without any further preparation, by means of a pair of pincers; this may be done in partial

mentagra during one sitting, but when it has spread very much several sittings are required; it can be done by the diseased person himself. The operation is for the most part easy and painless; in old mentagra, when the hair has become loosened, and the capsule somewhat separated from the papilla and the sac of the follicle, the hair falls out by itself, and it is only in fresh mentagra that the operation becomes painful. Epilation is sometimes accompanied by a slight effusion of blood caused by a fungous state of the infested parts.

After the epilation it is well to drop, by means of a pair of pincers, a sponge, or a fine brush, a solution of sublimate (5 parts to 100 parts of water) on the injured spots. This treatment causes sometimes an eruption of pustules on the lips and head, which must be opened with a needle on the following day. In order to prevent salivation, 1—2 parts of sublimate or 1 part of acetate of copper to 500 parts of water should be used.

Epilation produces an immediate improvement. The itching, pain, and tension of the lips cease; the hardened parts become more pliant; and the eruption of pustules retires. A single washing after epilation is sufficient; no internal treatment, no lotions or ointment are required. The patient need not go to a hospital, or only in the case of old mentagra which has spread over the whole face and the part of the skin which is covered with hair, and even then he may be dismissed in from 8 to 12 days. In slight cases, and when the parasite is absent, simple epilation without washing will be found sufficient; it is, however, better to employ both. The hair grows again soon, and often more beautifully than before. Cases of relapse are met with in some places which the patient is, however, quite able to treat himself. Pudendagra is similarly treated.

M. Santlus, of Hadamar, speaks favorably of epilation, and is confirmed by Didot of Brussels. He orders afterwards bandages wetted with "Aq. Phag. Pharm. Würtemb." The simultaneous internal use of graphite with guaiacum seems, according to Santlus, to be superfluous.

Literature.—Gruby, l. c., 1844, xviii, p. 585; Bazin, l. c., 1855, p. 41—43; Robin, l. c., p. 430—436; Gudden, Vierordt's 'Archiv,' xiii, 3, p. 504—506 (1853), Appendix.

VI. *Microsporon furfur = Fungus seu Epiphytes Pityriasis versicoloris.* (Tab. III, figs. 1—4.)

Trichomata (fila) in squamis epithelialibus sita, nunquam etiam earum marginem excedentia, multipliciter torta et inter se nexa, ut raro finis fili cujusdam certo cognosci queat; simplicibus, parallelis lineis terminata, nunquam aut articulata aut in margine vincta, nec contenti quid in eo apparet; passim in ramulos divisa. Sporidia rotunda binis adumbrantur lineis concentricis, quarum interior spatium lucidum circumdat; in acervulis agminata.

Habitat.—*In cute hominis ægroti.*

Ab aliis speciebus generis differt longitudine trichomatorum ac ramulorum et forma sporidiorum semper rotunda.

The parasite consists partly of elongated and branched cells (fila, filamenta, trichomata), partly of spores which are piled up in groups or in heaps, some of these being 100 mm. in diameter. They refract the light strongly, and appear, like all bodies which do the same, to be limited by two concentric lines, which are again bounded by a fine, bright space, which is, however, darker than the brilliant centre of the spore. Caustic ammonia added to the crusts or scales of the diseased skin renders the parasite more distinctly visible. Its seat is more particularly the skin of the breast and stomach, sometimes also that of the extremities, never that of parts which are exposed to the air. It grows rapidly, though the nature of the growth of the spores is yet unknown.

The appearance of this fungus is ushered in by the formation of more or less yellowish or yellow-brownish spots, which are constantly scaling off and itching, never rising above the level of the skin, and which are of various sizes and pulverulent on the surface. The whole forms the "*Pityriasis versicolor.*" These small spots are at first of the size of a pea, they increase, however, gradually and rise together, spreading to the breadth of two hands and uninterruptedly from the thorax to the body. The itching is increased by hard work and spirituous liquors.

Sluyter and Eichstädt have clearly proved that lying in a bed which was formerly occupied by any one suffering from "Pityriasis versicolor" will communicate it, and they doubt not that this disease is caused by the parasite. The evil is purely local; it

has never been found to occur previous to puberty, but always after the individual had reached from the fourteenth to the sixteenth year, and it seems more especially to attack such persons as are suffering from tuberculosis.

Eichstädt discovered the fungus in 1846, and after him, in 1847, much attention was paid to it by Sluyter; Robin himself did not find it; H. E. Richter describes it as *Mycoderma Eichstädtii.*

Gudden has occupied himself much with this disease lately without determining the nature of the fungus. The fungus establishes itself on the skin of both the healthy and the sick, especially amongst the poorer people. It is found, however, also on the most luxuriously clean and rich; more rarely on women than on men, *never* on children. It spreads mostly over the back and even the whole of the chest. It ascends often along the neck and attacks the extremities. Its horror of such parts of the body as are kept constantly bare is so great that Gudden saw a young man who went with his chest uncovered, and who was attacked all around by the fungus whilst the open space was left quite free and uninjured. These brown spots, called chloasmata, rise rarely above the level of the skin, and the finger experiences a rough sensation when passed over them. The surface, which is at first smooth, peels off after a little while. The disease concentrates itself, at first around small spots, which are seen, with a few exceptions, pierced by a little hair.

Means of discovering the fungus.—A vesicator should be placed on the diseased spot, and the vesicle removed as soon as possible and spread upon a glass plate suspended over a dark surface, and the soft serum removed from its lower surface by means of a fine pair of pincers, which is easily done with a little care. Nothing remains but the upper, thin, transparent, and firm layer, and its continuation on the sheath of the hair, so that the fungus is very well seen through it, as well as an innumerable quantity of small dots which appear to be whitish under reflected light, and darker by transmitted light. They are the openings of the perspiriferous glands, consisting of epidermal cells closely and flatly pressed one against the other, and which stand erect, are well developed, and contain a yellow pigment. These glands are very constant, and remain intact in the midst of the fungi. They are surrounded by spores, and present then darker, yellow-brownish, and funnel-shaped cavities. *The fungus does not penetrate into the cavities of the pores themselves.* The cells of the epidermis are

all normal, even to the lowest hard and horny layer. The cutis is sometimes a little redder, corresponding to the seat and extent of the spots. The masses of fungi may also be wholly or partially removed from the uninjured skin, leaving only a moist surface behind, by means of a myrtle leaf. H. E. Richter scratches off the scales, puts them under an object-glass, and moistens them with acetic ether. The fungus is well shown by this method.

Anatomy.—If a patch of fungi is cut out of the skin, together with the nearest surrounding parts, and placed under the microscope, and viewed from below and above, it is found that the fungus-patch lies in the uppermost horny layer. The patch imbedded between two layers, the lower and larger of which is formed by the filaments, the upper and smaller by the spores of the fungus. The vertical diameter of the patch is greatest in the direction of the hair-funnel, where the spores thrive best, thinner at the circumference—a proof that the fungi lie in corresponding layers. If such a patch is left in the water for twenty-four to forty-eight hours at the common temperature, the fungus, which has been soaked and loosened, may be removed by means of the curved couching-needle, without losing its consistency.

The threads are $\frac{1}{600}'''$ broad, round, serpentine, knotty, branching off in all directions, and entangled; they are transparent, slightly yellowish coloured, with moderately sharp outlines, and become smaller and paler by age, as well as in vinegar. The spores sprout at the end of a fibre, sometimes also at the side, and form very dense bunches of $\frac{1}{50}'''$ longitudinal diameter. If the bunches consist only of a few spores, the latter may often be seen on a little branch of the divided filament. Even spores torn off are branched or united in small chains. The spores are round, with a sharpish contour, and on an average $\frac{1}{500}'''$ in diameter. Many of them have one or two little bodies in their interior which refract the light more strongly, and which are rarely missing. Gudden does not regard them as nuclei. The fungus is, moreover, covered with a thin connected layer of epidermis, which is best seen where a fold in the skin is formed. Between the fibres and cells of the fungus there are fragments of the epidermis and molecular detritus. Almost every little patch is pierced by a hair, and the spores heap themselves up, especially in the funnel of the hair, descending deep into the

prolongations of the sheath of the hair, which they sometimes dye yellow by means of their mass. The spores may also be taken out of the sheath of the hair after maceration. They undergo no change except that they sometimes become thinner from below.

The patches increase gradually, and peel off superficially after breaking through the layer of the epidermis, in little whitish scales (*i. e.*, the cells of the epidermis and dried-up fungi). On the epidermis the fungi are found sometimes to run along the minute furrows. If the fungus withers, the yellow spot produced by the peeling off disappears and leaves behind for a longer period of time a smooth and less coloured spot. Gudden relates that a medical student had been infected by his brother, and thinks that the disease is contagious externally; his experiments on this subject were unsuccessful, because he scratched off the epidermis at the place of vaccination. The fungus is found on healthy and sick people; one kind of illness, however, being more favorable to its growth than another. It never penetrates into the deeper and softer, but only into the upper and horny layer of the epidermis, whence children escape unscathed, and the chemical reactions of the cutis are looked for in vain. The fungus of the favus (*Achorion Schoenleinii*) prefers the lower layers of the epidermis, and is therefore more especially the disease of children. Should it be confirmed that women are freeer from *Microsporon furfur*, it would find its explanation likewise in the nature of their skin. Gudden does not think that contact with the air by itself prevents the attacks of this fungus, but that it seeks and prefers the covered parts, on account of their greater warmth.

Treatment.—According to Sluyter, the applications of lotions containing a solution of liver of sulphur or corrosive sublimate are sufficient. According to more modern writers, *Tinctura Veratri albi* (in which, however, the alcohol appears to be the efficient agent) may be employed with success—a fact which I am able to confirm. Gudden, at an earlier period, when he was but imperfectly acquainted with the nature of this disease, and had but little experience, rubbed the back all over with soap, and, after the lapse of half an hour, directed the patches of fungi to be bathed with a lukewarm lotion and then with cloths steeped in solution of corrosive sublimate, until he saw the first signs of intoxication. But the evil returned after some months again and again. Von

Bärensprung ('Deutsche Klinik,' No. 6, 1855) thinks he has succeeded in curing the disease by using a lotion, with one grain of corrosive sublimate to an ounce of water. It appears to me very improbable that this remedy should prevent relapses without epilation, since the principal indication consists in removing or killing all fungi, even those found in the sheath of the hair. Blisters remove the skin and the fungus superficially, but after three or four weeks they spring up again.

Gudden adds nothing to this, and yet the treatment does not seem to be so difficult after the above indications. Let the outer skin be destroyed or lifted off, which may be done by vesication as well as by means of Helmerich's ointment (see Itch-mite), and let every hair be taken out immediately before or after. No doubt, it may even then not be possible to remove, at the same time, the sheath of the hair, and it will become necessary to apply, after epilation has been proceeded with, those anti-parasitic lotions which have been recommended in other places. The skin which is taken off is to be burned, and the clothes and linen disinfected by heat and steam.

Literature.—Sluyter, 'Dissertatio de vegetabilibus organismi animalis parasitis ac de novo Epiphyto in pityriasi versicolori,' Berol., 27th of November, 1847, p. 25, figs. 2 and 3; Gudden, Vierordt's 'Archiv,' xii, 3, pp. 496—504, with illustrations; Robin, l. c., pp. 436—439; Wedl, l. c., p. 735; H. E. Richter, 'Grundriss der Innern Klinik,' 2d ed., p. 1087.

It is interesting to compare with this the fungus mentioned by Fuchs in his work on the 'Diseases of the Skin,' ii, p. 538, as occurring in Alphis (white spots on the skin). B. Langenbeck made a drawing of it, which was not published at the time, and has probably been lost since.

VII. *Achorion Schoenleinii.*

Tab. III, figs. 5—11, and Tab. IV, fig. 12.

Tribe—*Oidiei*, Léveillé.

Receptacula simplicia, ramosa, floccosa. Sporidia terminalia, ramulis adhærentia aut verticillata.

Genus—*Achorion* (Link and Remak): *Orbiculare flavum, coriaceum, cuti humanæ, præsertim capitis insidens. Mycelium = rhizopodium molle, pellucidum, floccosum, floccis tenuissimis, non*

articulatis, ramosissimis, in stromate granuloso plerumque affixis, anastomoticis. Receptaculum floccis crassioribus e cellulis elongatis formatum, subramosis, distincte articulatis, articulis inæqualibus, irregularibus, in sporidio abeuntibus. Sporidia rotunda, ovalia, vel irregularia, in uno vel pluribus lateribus germinantia. Species Oidio affinis. (Remak.)

Remak described the mycelium as articulated, which Robin considers to be erroneous. Remak called also the tubes formed by the spores mycelium, and supposed the tubes of the mycelium anastomosed among themselves, whilst this takes place only with the articulated filaments of the spores, according to Robin. Oidium differs from Achorion in the tubular filaments which lie exposed, and are not inclosed by an external thick and smooth layer.

Species—*Achorion Schoenleinii.*

Synonyms: *Oidii species, Oidium Schoenleinii,* Mycoderme de la teigne, Cryptogame de la teigne faveuse, Champignon de la teigne scrophuleuse, faveuse, *Fungus Porriginis.*

Signa generis.

Habitat: *In cute capitis humani, etiam in aliis corporis regionibus, et in folliculis papillorum inque depressionibus superficiei cutis; porro in unguibus digitorum manus et pedis.*

It had been overlooked, until Robin and Bazin pointed it out, that this parasite attaches itself to the bottom of the hair-follicle in the direction of the hair, more commonly, however, to the simple layer of the cells of the epidermis. Here spores only, or closely articulated filaments, are met with. These spores adhere for the most part to the hair, and create on its surface circular enveloping masses, which spread out more or less, and form a kind of sheath for it. Sometimes the spores occur close together, sometimes forming single, double, or treble rows, which are connected by means of smaller rows, and form a kind of network, which adheres firmly to the hair, and often appears discoloured on account of the copious layer of spores. Sometimes the spores penetrate into the root of the hair, which becomes then disfigured, dried up, and fibrous, even in the interspaces between the fibrillæ. Spores are likewise found at that part of the hair which lies free, outside the follicle, on the angles formed by the hair in its folds, &c. The hair-follicle is changed, moreover, as well as the bulb of the hair, and it becomes atrophied and thin. The penetrating of the spores into the follicle explains the pertinacity of favus.

If the parasite be found accumulated in the depressions of the

surface of the skin, forming what is called a cup = "godet = favus," in the proper sense, we meet not only with spores, but every anatomical part of the plant mycelium, receptacle, and spores. These lie at first underneath the epidermis; they penetrate gradually, still covered by the epidermis, into the follicle, and unite with those of the neighbouring hair, whilst the skin becomes thinner. When the favus is very large, it frequently throws off the dried epidermis, and the parasite becomes exposed to the air. The skin around the hair becomes depressed, thinned, resorbed, and the opening of the follicle changed. When the parasites of several infected hairs run together, large crusts of favi are found, underneath which the skin is changed to a large extent; and between the inclosed diseased follicles we find also some healthy follicles. The glands of the hair become narrower and smaller, they contain, as they do in a healthy state, only a few drops of oil, but a large quantity of a granular substance, and their channel of excretion is thread-like, and probably obliterated.

A considerable number of such fungi unite to form little peculiar hemispherical masses, from 1—15 mm. in diameter, and from 1—4 or 5 mm. in thickness, and are on their free side even or concave, on their attached side convex. Their colour is pale brimstone-yellow, sometimes a little browned by foreign bodies. Their whole convex portion is inserted into the skin, whence the latter is depressed, smooth, and sometimes slightly embossed, exhibiting oftentimes small branch-like elongations or very short and blunt little warts (Lebert). The free side is at the same time the broadest of the favus, often covered with suppurated epidermal layers, called dry crusts, to which they bear not the least resemblance. Whilst the favus is not fully grown it possesses a cup-like cavity in the centre, which fills up as it grows. A very large favus shows alternately salient and depressed lines, in various numbers, all around the centre of the favus; they are arranged in irregular circles, and ordinarily pierced by one or more hairs. The edges of the free side often adhere to the epidermis of the skin, and are covered with a dried-up substance, forming small, transparent, brownish or grayish crusts, which do not belong to the parasite, and which must be taken away if the favus is to be removed. One or more hairs always pierce the favus in an oblique direction at those places which are provided with hair. When it is removed it is found that the hair penetrates the skin, and that the follicle lies still deeper. It

has been wrongly stated that these formations have their seat in the principal part of the follicle of the hair, or of the glandulæ sebaceæ. At the spot which has been freed from the favus there remains a smooth impression—red from irritation, which, however, soon disappears, often in the course of an hour, in consequence of the elasticity of the skin when freed from pressure.

Structure of the favi.—In order to study carefully the structure and construction of the fungus, it is well to examine, first, the normal structure of the shaft of the hair, which is thus described by Gudden. The shaft of the hair and the inner sheath of the root consist of a modified epidermis composed of bright transparent cells, which are round below, becoming flat towards the upper part, and stretching out to a considerable length, parallel to the shaft, perhaps even losing their nucleus, whilst the layer of epidermis of the skin consists of smaller round or elongated cells. This may be seen best by drawing out the shaft of the hair, together with its inner sheath, and separating it from the epidermal layer of the skin. Since this does not always succeed, the layer of epidermis of the skin may be torn off by means of a curved and not too sharp couching-needle, and split longitudinally, when the single cells are usually brought out very distinctly at the edge.

The favus is hard, dry, brittle; its fracture is shining; its interior whitish-yellow, and paler than the outer surface. When examined with a lens, it is seen to be spongy, or even a little hollow in the centre (Lebert); when seen under stronger powers, its contents appear to be the tougher the nearer they approach the surface, forming a thin, dense layer, which acts as a kind of cover.

The exterior layer = "stroma" = "gangue amorphe," is one sixth of a millimetre in thickness, forming a finely granulated amorphous mass, representing a membrane which cannot be isolated, belonging, nevertheless, to the favus, and is not the result of the drying up of the amorphous, albuminous, exuded mass, nor of an accelerated formation of the epidermis, nor of the drying up of the pus or the mixing of any one of these substances with the other. It forms the amorphous, homogeneous, very finely granulated stroma, consisting of organic substances or the *gangue amorphe* common to all fungi.

The inner surface of this outer layer passes gradually into the central part; it is spongy, easily rubbed to a yellowish-white dust,

representing, under the microscope, a mixture of mycelium, receptacles, and spores, which show clearly the various steps of transition among themselves.

1. The *mycelium* is formed of curved, bent, and simple cylindrical tubes, forked or branched in all directions, with partition walls, which are smooth and oblique, standing at unequal distances one from the other. The tubes are strangulated and articulated, and have an equal diameter of 0·003‴ all along, and are bordered by a smooth and pale edge. These tubes communicate most frequently with those of the branches, sometimes they do not, and they are then separated by a wall. The edges of the tubes are simple, smooth, of dark colour, and their transparent surface without granulation in the interior. Sometimes one end of the cavity is seen free and floating, and the other adhering and communicating with the granular stroma. A finely granulated mass is found between the joints, and the sporidia are interspersed between the thallus-threads. Robin denies the presence of joints and partition walls in the latter.

2. *Receptacles* or *sporophora* (the spore-tubes of some writers) are tubes analogous to those of the mycelium, with short joints, slightly contracted externally, cylindrical, usually less flexible and brittle, so that they break up easily into single parts, empty in one part, and provided in the other with small globules of 0·001—2 mm., or with a single isolated corpuscle. Other tubes, neither flexible nor branched, but straight or slightly curved, contain similar, yet larger granules, of 0·004—5 mm., which are, however, in closer proximity one to another, especially towards the ends of the tubes, without ever touching entirely. The last and broadest tubes, with occasionally occurring partition walls, are denser (0·005 mm.) and longer and contain spores, which are closely connected with one another. The tubes are 0·05—20 mm. long. There are also spores of 0·005—7 mm. in breadth, and 0·007—11 mm. in length, provided with joints at certain distances, and contracted at those places of juncture in which the common envelope is no longer recognised. Sometimes, by a division of the sporules, these rows are divided into two or three smaller rows. It is uncertain whether these spore-tubes generate in due time new ones, either at their origin or free end, as in other cryptogams.

3. The *spores* are generally round, spherical, oval, or irregular, consistent, sometimes joined together and provided with smooth,

very marked edges, 0·003—6 mm. broad, and 0·007—10 mm. long, not changed in water or vinegar; homogeneous in their interior, transparent, and refracting the light strongly, and are found, on closer examination, to be filled in their centre with a very fine powder of molecular granules, and exhibiting, on the addition of water, a molecular motion of the spores (Lebert, Remak). Some of the largest round spores show a small granulation of 0·001—2 mm., and the longest the same at each end. There are, likewise, ovoid, almost four-sided spores, triangular and rounded off at the corners, which are swollen at the ends and contracted in the middle, spherical and longish, and grouped together, forming a simple or sometimes a fork-like divided row of from four to twelve spores. Sometimes only spores of the same size are grouped together, sometimes of different sizes, and sometimes the ramified tubes are found to communicate amongst themselves. This fungus should be examined with a power of from 500 to 600 diameters.

Seat of the favi.—They are principally found on the head, covered with hair, but also on all other parts of the body; on the face, the shoulder-blades, the external ear, on the front of the thighs, the penis, and the testicles, and not merely on those parts of the skin covered with hair. At first a reddened spot on the skin, with a yellow dot in the centre, is perceived. If this spot is opened, a drop of matter is sometimes seen to exude, sometimes not; and below lies the readily formed mass of fungi as a yellow knot. The favi are imbedded in the skin, which is depressed and thinned by them; their surface is firmly attached, by immediate contact, to the depressed part, which is deeper in the skin of the remaining part of the body than on the head. As soon as the mass of fungi becomes exposed to the air, after the loosening of the epidermis, a scab is deposited, sometimes with and sometimes without pus, and the external edges still covered with epidermis, which must be cut off if the scab is to be detached. When the scab is quite dry, this operation rarely succeeds completely. Broad crusts of 1″ diameter and more are formed by continued exudation. The opening of the canal of the hair is, therefore, no necessary seat of the favi, but becomes so in the course of its spreading; in small favi, from 3—4 mm. diameter, they are seen to be pierced by four or five hairs. The adipose tissue has been erroneously thought to be their seat, and they were even regarded as hyper-

trophied sebaceous follicles. It is most probable, according to Bazin, since the favus-matter is constantly found at the lower portion of the epidermal part of the channel of the hair, below the opening of the follicle in the skin (Bazin's "terminaison de la membrane capsulaire interne,") that the parasite originates here, and is sending its branches forth into the interior of the hair, and outwardly underneath the epidermis. The epidermal canal is firmly attached to the hair, preventing the free exit of the fungus, and forming the centre of the cup-like cavity (godet). On growing, the fungus moves more towards the skin between the two layers of the epidermal envelope.

The fungus shows itself simultaneously in several capsules of the same follicle, when the favi occur in groups (*Porrigo scutiformis*). The little cups of the favus press one upon the other, become deformed, and burst the skin which covers them. This is proved by the fact, that the *Porrigo scutiformis* becomes, after the first epilation and washing with the favus-remedy, a *Porrigo disseminata*, which after several weeks runs again together from the remaining milk-hairs. On other parts of the body, where the hair is destroyed, and the bulbs not deeply seated in the skin, only the disseminated favus is found. Gudden has even more accurately determined its seat. He considers the normal epidermis, or the epidermal tissue in general, and the little funnels of the hair in particular, to be the original places of germination of the Achorion, from whence it spreads into crevices and wounds. Its spreading is very much assisted by a delicate, moist skin. The fungus penetrates from the hair-funnels either into the hair itself or into the surrounding epidermis, forcing its filaments inside the sheath between the scaly rings, which they drive away from the shaft of the hair, or, penetrating deeper and undermining the whole, cover it in all directions. They arrive thus sometimes, but rarely, between the longitudinal fibres, and then run parallel to the longitudinal axis of the hair. Wedl gives a similar illustration of it, and this is no doubt the reason why Hebra declares *Herpes tonsurans* and *Favus* to be identical. If, however, the immense bulk of the hair occasioned by the spores in *Herpes tonsurans* is compared herewith, and if, moreover, the observations of so acute an observer as Gudden are repeatedly confirmed, that the spores never penetrate very far and very deep into the tuft of hair, nor very far into the epidermis of the skin below the hair, *i. e.*, into the outer sheath,

it will become clear that the fungi of *Herpes tonsurans* and *Favus* are very different, and have, therefore, been treated separately here. H. E. Richter is of the same opinion, based, moreover, on the variation in the size of the parts of the fungi. According to Gudden, favus-fungi are never found in the canals of the sudorific glands or of the sebaceous follicles.

Growth of the Achorion.

a. *Germination.*—Remak could not succeed in germinating spores, in pus, muscles, cerebral substance, serum, or on solutions of sugar, but he succeeded very well on an apple, and on his arm. (See author's *Appendix* for further information about these experiments.) Gudden states, with regard to the possibility of conveying the disease by means of the spores to other individuals, which was proved by Remak and Bennett, that the transference to uninjured bodies fails, whilst it succeeds very well after removing the outer skin, which may be done either by a vesicator or by scratching. It becomes then merely necessary to allow the favus to be tied on such places for 36—120 hours. Hebra was unable to notice any propagation of fungi of the favus by means of inoculation, but only redness and the formation of vesicles.

b. *Development.*—According to Lebert, Remak, and Gudden, there is seen, near old crusts, a small, round epidermal elevation in the midst of them, together with a small yellow body (the favus). If the epidermal layer which covers this body is raised, a drop of pus is sometimes seen to exude, underneath which the little favus lives and thrives, possessing a smooth surface and deeply imbedded in the skin. The pus is often wanting, and the fungus forms a small, firm, yellow spot. If the epidermal layer is removed, and the fungus exposed to the air, it grows and clothes the neighbouring hair, without producing pus. It adheres firmly to the skin, its surface is dry, well defined, and slightly covered with epidermis. On removing the favi new ones spring up. Ignorance of these processes gave rise to the erroneous descriptions of the favus by some pathologists, as, for instance, Cazenave.

The favus passes, according to Bazin, during its development, in three periods, through three different stages, which occur sometimes simultaneously on the same head, and which have been described by authors as separate species—*Favus urceolaris*, *F. scutiformis*, and *F. squarrosus.*

During the first period the hair becomes altered, not so the skin at the place of its germination; gastric disorders are seldom or never found.

During the second period the change in the hair becomes more perceptible; the fungus appears outwardly as a yellowish concretion, with or without being preceded by congestion of the skin, and exhibits all its regular stages of development.

During the third period the alteration of the hair has reached a high degree, the hair falls off by itself, and leaves merely scars behind. The few diseased places are covered with lichenous débris, or crusts resembling pulverized alum or gypsum.

The *species* of the *favus* are nothing more than variations in form according to the different states of reaction of the cutis in relation to the fungus. Thus the following forms may be traced:

1. *Favus disseminatus, F. isolatus, F. independens, F. urceolaris, Porrigo favosa, Tinea lupinosa, F. alveolaris,* &c.—It is found on all parts of the body covered with hair, but more especially on the back of the head, spreading sometimes over the whole surface of the body (*Favus generalis*), now alone, now associated with other skin diseases, and particularly with *Herpes circinnatus.* It has likewise three periods. During the first, which is of various duration, there exists sometimes a disordered digestion, sometimes not. The hairs are frequently altered, without lustre, feeble, and strikingly differing from the colour of the healthy hair; finally they become quite colourless. On endeavouring to pull out the hair it offers little resistance, and the microscope shows its texture to be very much altered. The parts which constitute the shaft are wholly or partially destroyed. The colour is a dirty, grayish or brownish-like rust or blight. Distinct traces of the fungus are observed at the bulb and at the continuation of the root of the hair.

Gastric disorders become frequent during the second period. If the fungus is examined at its origin with the naked eye, it appears mostly as a yellow, scarcely perceptible point, with a ventral impression, pierced by a hair. The first trace of the development of the fungus may be discovered by means of a pocket-lens; sometimes a slight rising of the skin is observed on the spot where the hair penetrates it, sometimes a small point aside and underneath the skin, or also two or three small, yellow, isolated concretions parting at the basis of the hair, which form on the following day a single, conically excavated concretion

pierced with a hair in its centre. The yellow crust grows very rapidly: its vertical diameter increasing $\frac{1}{2}$—1‴ during twenty-four hours; the ventral depression becomes daily more characteristic, and may be compared to the alveoli of the honeycomb, or to the depressions on beans, or to the small cups of the yellow lichens on the branches of trees. Sometimes the inner surface of this depression is quite smooth and even, such as is seen in the cups of the oak; at other times uneven, and exhibiting a series of concentric circular elevations, the number of which indicates to some extent the age of the cup of the favus, and which resemble, from their position, the circular prominences of the nests of swallows. The younger these layers are the more saffron-coloured are they; the older, the whiter. The last layer raises sometimes the epidermis several millimetres above the level of the surrounding skin. The cup of the favus may even reach more than two centimetres in breadth; the fungus makes, however, its exit before it reaches these dimensions by breaking through the epidermal covering almost always some millimetres above the point where the crust is pierced by the hair; it makes a hernia through this opening, and shows no longer any regular form during its growth.

Complications.—The cups of favi run together and open a free passage for the favus at another place. The patient often scratches off the epidermal covering of the favi, causing a few drops of blood to flow, which dry on the crust. This increases the irritation of the scalp, produced by the presence of the foreign body, and leads to the formation of real impetiginous pustules and crusts. If the alveolar crusts of the favus are removed, by the nails of the patient, by poultices, or by the physician himself by means of the spatula, the surfaces which lie underneath are found to be depressed, red, bleeding, and covered with a thin epidermal layer, above which are often seen the vessels and fibres of the skin. If the crusts are carefully removed without injuring the skin which lies underneath, a transparent lymph without blood exudes.

After removing the fungus, the depressed part dries and reaches in a few days again the level of the surrounding skin. The eruption of the favus daily covers more and more of the scalp; its progress is sometimes rapid, sometimes slow, according to the cleanliness of the diseased persons attacked, and other conditions.

After various intervals the patient arrives at the third period, that of baldness.

In spite of the application of emollients and lotions the head of the patient exhibits a certain inflammable redness, disorders of digestion come on, and a painful feeling of oppression; a sign that a foreign body has its seat in the follicles of the hair, which sustains the irritation. This redness only disappears on bald places and on the scars which succeed the falling off of the hair. The hair becomes altered more and more, loses its colour, becomes atrophied, varying in its diameter in different places, it becomes mouse-gray or ash-coloured, woolly, and falls out. The hairs may be drawn out with their bulb by means of a pair of pincers, or they separate from their root by breaking off at the level of the skin. The bare spots form complete scars, in which the bulb of the hair and the whole pigment are destroyed by the fungus. Sometimes remains of the hair are seen entangled in the epidermis. Baldness commences, as in most diseases of the scalp, in the back and lateral parts of the head; the back of the head resists longest. The mass of favi may be compared to dried birds' dung, and is possessed of a most repulsive smell, similar to putrefying animal matter. During this latter period the favus is apt to spread to other parts of the body, and this spreading is accelerated by the simultaneous *Herpes circinnatus*, or by the scratching of the patient. The *Favus alveolaris* is found in every region.

2. *Favus scutiformis, F. nummularis, Porrigo scutulata, Favus* in rings, circles, groups, &c.—It is primary, or follows chronic eczema, impetigo, or lichen, and exists only in the scalp, and in conjunction with a strong growth of the hair. The alteration of the hair is, during the first period, less perceptible than in the last form. During the second period this species appears at first as a more or less extensive round spot, from half an inch in diameter to that of a five-franc piece. The pericranium appears elevated, swollen, reddish, and painful; the surrounding regions depressed. Sometimes the hair which covers the spot is surrounded at its base with a small epidermal capsule, whitish or yellowish-white, forming a kind of covering to the hair. This excessive formation of epidermis continues a long time, and the favus might then easily be mistaken for pityriasis of the scalp. The form of the affection, the adherence of the scales, the gum-like aspect of the epidermal covering of the hair, the colour of the branny scales, form the distinctive characters of this disease. The cells of the epidermis become smaller and

more rhomboidal, the tubes of the mycelium and the spores are seen, by the aid of a pocket-glass, before the yellow mass of favus can be recognised, which is the result of the accumulation of these cryptogamic elements. This hyper-secretion of the epidermis may last six weeks before the yellow concretion of favus manifests itself. The alteration of the hair progresses daily, but the falling off of the hair takes place only after some years. There is rarely but one spot of favus; in most cases there are several, sometimes only two, three, or four, distributed over various regions of the head; they spring up simultaneously, or one after the other, in the same parts; they unite and form a large crust, which occupies one third, two thirds, or even the whole scalp. A small strip of hair remains frequently untouched on the forehead, as well as the lower part of the occipital region and of the nape of the neck. Half-circles are often found around the diseased parts, which remind us of the first development of the circular spots. The diseased spots are covered with favi, more or less irregular, fragmentary crusts, often elevated at the edges, pierced by hairs, and impregnated with dry blood, possessing a faint, often stinking smell, and sometimes concealing lice; although these guests are more frequently found in *Impetigo granulata*. The *Tinea scutulata* makes at this period its appearance also in other parts of the body, called then *Porrigo favosa;* sometimes even at the same time with the first species. The cure is, in this case, often accompanied by a considerable contraction; the hair grows, however, again very easily.

3. *Favus squarrosus* = *Porrigo squarrosa.*—This species is often mistaken for the preceding. They differ, however: the outer development of the fungus does not proceed as regularly; it takes place on more or less prolonged, uneven, irregular surfaces, which are limited, but very inaccurately. The mass of favi spreads over the hair and forms sheaths for it, which adhere very closely, producing thus distinct elevations on the surface of the head, and small, prickly warts, with fragmentary, powdery crusts, separated by deep furrows.

Detailed description of the scabs of favi, according to Gudden and Remak.—The scabs form round or oval discs, measuring from 1—1½‴ in diameter, and depressed towards the middle. They are of a dirty yellow on the surface, changing to a dirty white towards the centre, and raised a little above the level of the skin. These

discs are frequently pierced by a hair in the centre. There are concentric furrows all around, dividing the scabs into a number of rings, from $\frac{1}{4}'''$ in breadth, gradually spreading on the outside. The epidermis grows thicker on the edges, peels off, or remains in the middle of the scabs. By carefully piercing the epidermis on one side, the scabs may be lifted off easily, and without injury, from the cavity of the cutis, together with the adherent neighbouring parts of the epidermis. The lower surface is convex, yellow, smooth, and moist, from whence they can be stripped off in the form of a rapidly drying layer of numerous, young, round, and slightly granulated epidermal cells, which are rapidly converted, on the edge of the scabs, into the great flat and irregular epidermal cells of which the scab consists. Simon denies the existence of a cellular layer between the cutis and scab. Gudden always noticed such a layer breaking up into a molecular mass in the neighbourhood of the fungus. The next following layer of the favus becomes thinner towards the centre, and ceases entirely in the middle of the cavity. It is of a brimstone colour, $\frac{1}{10}$—$\frac{1}{6}'''$ in thickness all over the scab. This is commonly called Gruby's capsule. It is best seen by slightly pressing upon a thin vertical cut in the scab till the layer separates from the inner darker mass, and by soaking it with water, when it may be unravelled by means of a needle parallel with its perpendicular diameter, when the entangled threads—now and then exhibiting little vesicles of chlorophyll—are seen to advantage, and between them a molecular detritus. The fungus spreads but little towards its lower end, whilst it branches out variously towards its upper part, and makes rapid transitions, at the inner border of the capsule, to the variously intertwined rows of cells, which rarely exhibit a single thread. These cellular rows and the detritus form the central, grayish-white, and easily crumbled part of the scab, which are easily crushed in water. A great number of little bubbles of air or carbonic acid are seen at the place of transition to the filamentous layer. The smallest scabs, which are scarcely seen with the naked eye, form a flat crust, consisting only of filamentous favi, and, imbedded in the upper layer of the epidermis, covered by flat epidermal cells. It may be prepared by loosening the epidermis, and is often quite inclosed by the latter; and the windings of the excretory duct of the perspiratory glands may even be recognised at the lower part of this cellular layer, which, however,

is spared by the favus, as well as the sebaceous follicles, which are very strongly developed during a powerful reaction of the skin. The renewed growth of the hair of persons who suffer much from favi and the falling off of the hair at the period of puberty, shows that it is seated in the epidermis. The above-mentioned little capsule gradually increases and moves downwards until it reaches the lowest layer of the cutis, where it spreads more luxuriantly in all directions. Its higher edge encounters a still more resistent epidermal layer, projects against it, and forms a yellowish, pretty-looking little nest, harbouring in its cavity, cells and air-bubbles. The capsule is formed when the edges are gradually bent inwards, often leaving only a small opening in the centre. When the scab has once settled in the lower layers of the epidermis, new layers of favi are continually seen to make their way to the light; whilst the lower layers remain unchanged. Their development ceases on drying the filaments, but recommences when they are put into water and soaked. The concentric rings, described by Simon, in scabs, are merely caused by the turning up of the layers of the scab. Sometimes a small opening is seen in the middle of the disc (Gruby), from which the favus grows, and which was forming simultaneously with the latter, and is only covered by epidermal cells. The scabs also run together (*Porrigo favosa, Favus conspersus*). When the formation proceeds rapidly, and when a crust is formed about every hair, the crusts press on each other, the scabs increase and rise on account of their humidity, between the hairs. Most instructive microscopic preparations may be obtained by detaching the freshly formed scabs, after cleansing the scalp according to Gudden's method (see below). Sections of the older scabs exhibit two layers, separated mostly by a line of demarcation. The thinner, whitish, and crumbling inner layer contains the thallus-threads; the free and thicker yellowish layer the sporidia and spores. (Remak.)

Diseased phenomena produced by the favus.—Remak experienced no change of general health during the time the artificially created favus was active; nor is there any change perceptible in strong children, should the disease even last for years. It is, however, very doubtful whether an extensive suppurating favus acts in the same way as other diseases of the head, like the impetigines, which act vicariously, by replacing chronic inflammations and mucous discharges of the conjunctiva, the cornea, and the auditory

passages, and by taking the place of swelling and suppuration of the cervical glands, swellings or atrophies of the mesenteric glands, perhaps also of tubercles of the lungs, the bones, and the intestinal canal. The development of the fungus is sometimes accompanied by a peculiar odour, like the odour of the urine of a cat, by painful excoriations, and by a swelling of the neighbouring lymphatic glands. A large development leaves behind scars in the skin; the latter loses its pliancy and imperviousness, and the hair does not grow again, probably on account of the atrophy of the bulb caused by pressure. Oftentimes it is accompanied by an inconvenient and violent itching, and sickly feeling. The favi spring up again and again, cause the hair of children to fall out in various places, and produce great pain, sickness, and, to some extent, imbecility, thus imparting considerable importance to this disease. It is also followed by *Pityriasis, Eczema squamosum,* and *Impetigo,* when it lasts long. Ulcers were never observed by Gudden; they may, however, happen, even very deep ulcers, like those which accompany the itch. These may be caused by a secondary action. A very serious addition has to be contended with in the numbers of lice which aggregate on the diseased parts.

Differential diagnosis.—The branny dust in pityriasis consists of epithelial scales, in dried-up layers or lamellæ. The eczema-scales or crusts, which often cover the favus, may easily be distinguished from the latter at a glance. The favus, when it is detached, often depends from its base in the form of a small yellow tubercle. The colourless thin crusts consist only of epithelial scales, lying one above another, and held together by a serous plasma. The yellow crusts are saturated with blood and pus, produced by scratching; the brown, or earth-gray, crusts consist of decomposed particles of blood. They can be easily recognised by treating them with water and vinegar.

Pustules of *Impetigo* are easily distinguished; they are prominent and convex, with a yellow centre, the skin being inflamed all around. Pressure causes them to discharge pus. Their scabs contain no trace of favi, but of dried-up pus-corpuscles and epidermal scales.

Older writers often confounded *Achores* with *Favus.* The achores are small yellow pustules and ulcers, which become perceptible when the hair is cut off; they surround the root of the hair, and appear depressed in the centre. They soon dry up

and form crusts, consisting of epidermis and pus, and cannot be enucleated. (Lebert.)

Special changes of the hair.—The hair is restored from time to time, but always in an altered condition, and has more of a milk-hair-like appearance; it splits also longitudinally into fibrillæ, which sometimes are entangled, sometimes ravelled out, and is dotted all over with molecular granulations, epithelial cells, and numerous spores. The hair is never entirely lost, except on the oldest diseased parts. According to Bazin, the shaft is sometimes the only diseased part, sometimes the favus-matter is found on it here and there, when the hair looks dead, lustreless, and the external layer and medullary substance are usually mixed together, and the longitudinal fibres are broader and thicker than in the normal state. Other hairs exhibit a change of the inter-follicular substance; spores and mycelium-tubes are found on the membranes, or sometimes favus-matter in large quantity between the prolongation, in root-shaped prolongations, and the *tunica interna* of the follicle of the hair, as a kind of conus, the point of which lies between the radicles of the hair and the inner part of the capsule, and the rugged basis corresponds to the upper end of the inner tunic of the follicle, and has in front the epidermal channel of the hair. Other hairs show also no follicle, or merely a few broken pieces. The bulb of the hair, the root, and the root-shaped prolongation of the hair are interspersed with spores and tubular filaments. Sometimes globules of pigment are seen at the nearer end of the longitudinal fibres, sometimes they are without pigment. Spores and tubes of the favus are met with even in the centre of the shaft. The highest degree of degeneration of the hair is marked by atrophy and discoloration, when it exhibits on the edges tubular filaments, proceeding from the centre of the hair, similar to the changes which the latter undergoes in *Herpes tonsurans*.

Bazin recapitulates thus the changes of the hair:

The change of the hair does not proceed from the pressure of the favus on the hair.

1. The constituent parts of the bulb themselves are altered, producing a disturbance of their inner texture, and not merely atrophy.

2. The follicles of the hair are likewise under the influence of the disease.

3. The favus and its intra-epidermidal part is most frequently

found between the upper extremity of the *tunica interna* of the follicle and the epidermal sheathing of the hair; and the bulb even disappears during the last period of the development of the favus.

According to Gudden, the imbedding of the favus in the hair renders the latter white, rigid, brittle, and unravelled at the point. The hair is opaque when examined immediately after the addition of water, because the air which exists between the longitudinal fibres and circular scales, or which is formed into small vesicles, gives to the whole the appearance of a row of cells, till it passes finally out by way of the circular scales on the side collecting on the surface, and forming larger vesicles, which, however, recede into these spaces as soon as the hair becomes dried up. The hair becomes more transparent as soon as the air has escaped, the greater portion of which is atmospheric; the smaller, perhaps, consisting of carbonic acid; for some vesicles are rapidly absorbed by the water, and little drops of oil are seen floating about.

Etiology of Favus.—It is found in every age, mostly in children. All modern writers agree that a scrofulous constitution does not alone produce it, but that various diseases, misery, privation, and unhealthy habitations, likewise foster it. The sole cause of the favus is the transfer of the spores to the skin, which may be effected in various ways. Few persons who have daily to treat favus become themselves infected, and it may therefore be well to presume, with Robin, that a predisposition to it exists in the individuals attacked by this disease. It would be more correct to say that contagion takes place only in the case of open wounds, broken skin, &c., by which the spores of the favus are attracted and developed. It is very doubtful whether it is hereditary. It has not yet been thought worth while to ascertain whether the children of parents who were infected with favus had not come into contact with other favous persons, and thus incurred the disease. Favi have only been seen on the human skin. It is not known what kind of skin is most advantageous to their growth. There is no reason why the favus ought not to be considered as the primary cause, and not merely as the bearer of a peculiar hypothetical favus-contagion.

Reactions relating to the diagnosis of the favi and the epidermal crusts, according to Bazin.—Distilled water at the common temperature, or boiling, rectified spirit, ether, and chloroform, do

not dissolve the pure mass of favi; they are left unaltered, whilst fatty matters are easily dissolved. The epithelial masses become thin by this treatment. Ammonia renders the favus-mass a little paler, but does not dissolve it, whilst it dissolves pus and impetiginous crusts, forming a milky gelatinous mass. An alcoholic solution of potassa, especially on being heated, dissolves impetigo-crusts, pus, skin, hair, fatty matter, and sebum, but not the favi. Nitric acid is coloured yellowish-brown by crusts of the impetigo, which, after a few hours, become of a turmeric yellow; masses of favi impart to it a golden-yellow colour, turning to straw-yellow, especially after the lapse of a day. Sulphuric acid attacks favous and impetiginous masses, and is turned reddish; the crusts of favi, however, become porous, pumice-stone-like; the impetiginous crusts gelatinous. Chlorine gas discolours favous and impetiginous masses, hair, &c. Mouldy formations show the same reactions as the masses of favi. Hebra is of opinion, as already remarked, that favus and *Herpes tonsurans* are identical; to which he seems to have been chiefly led by the circumstance that the spores of the favus and of *Herpes tonsurans* penetrate into the interior of the hair itself; that the favus-fungus, occurring on the body and back and forming scabs, cures itself, like *Herpes tonsurans*. His opinion that the favus is merely a further stage of development of *Herpes tonsurans* seems to be principally based upon two cases described in his periodical, one of which having quite the appearance of *Herpes tonsurans*, exhibiting the favus-fungi, when it was examined under the microscope; the other, however, showing the favus-fungus exactly as it was observed on the head, and in scabs on the top of the nose. On looking closer to the latter case, I am uncertain whether Hebra really understood, by *Herpes tonsurans*, what we have understood by it; for he does not speak of fungi in the hair, but only of epidermal accumulation of scales, the latter being but accidental to *Herpes tonsurans*.

The fatty substances of sebum and cerumen exhibit vesicular granules, rhombic crystals, and epithelial cells; the sero-purulent and purulent masses show granulated globules and globules of pus, but are not, however, to be confounded with favi.

The favus-fungus may be distinguished by the above-described thallus from the ferment-alga, which resembles only the sporidia of the former.

Pustules and favi may be thus distinguished:

Pustules.	*Favi.*
Colour whitish or slightly yellowish; surface even, or slightly convex, with a scarcely perceptible depression at the basis of the hair; discharging matter on application of a slight pressure or on pricking with a needle, which spreads also into the areoli of the *corpus mucosum* of the skin; covered with an extremely thin epidermal layer; the bottom of the pustules is formed by the papillary bodies of the skin. The change of the pustulous contents is less rapid and regular, and, as is the case with all diseased products, it becomes hard, forms crusts, and does not grow any more.	Colour of brimstone, with a very distinct alveolar depression; rarely discharging a drop of pus when pricked; easily detached from the skin; the epidermal layer which covers them is more resistent and has underneath a second thin layer, thus placing the fungus between two epidermal layers; the development of the favus-contents is very rapid and regular, and may be continued infinitely.

A transition of the favus into pustules, either by continuity or contiguity, has, moreover, never been established. Cases where the centre is formed by a fungus are most liable to be confounded when this centre is surrounded by a purulent ring, without its ever mixing up with the former, a case which may best be studied in *Porrigo scutulata*.

It is further of importance in diagnosis, that the three species of glands occurring on these parts of the skin should be considered.

1. *Perspiratory glands*, or follicles with a spiral tube, opening on the surface of the skin.

2. The *sebaceous follicles*, which do not branch, but end in a sack; simple grape-like glands, which have wrongly been called *folliculi sebacei*, and which secrete the sebum. They open on the surface of the skin, often in conjunction with the opening of a hair-follicle, which fact was denied by Bazin without giving any reason.

3. The *hair-glands* (*glandulæ pilosæ*), which are small glands, rarely consisting of one, but mostly of two, three, or more blind sacs, lined with epithelium, filled with drops of oil, and containing one or two passages which open into the hair-follicle, where the skin is pierced by the latter. They are more particularly attached to the hair-follicle. The number of blind sacs rarely exceeds one, two, or three with man, whilst they are found to be more numerous with other animals.

Treatment of favus.—Once developed, it is difficult to cure, though cases are known where nature has cured it, because, according to Remak, the accessory suppuration lifts off the whole scab, and with it the fungus. It will, however, be easily perceived that this is only possible when the scab which becomes loosened is removed at the same time with the hair and its roots or sheaths—a very rare occurrence, no doubt. Most of the older remedies which have been proposed have proved inefficient, for as soon and as often as the favus is removed it grows again.

Indications.—Of primary importance are extreme cleanliness, and treatment of the cachectic state of the patient; then the cutting of the hair, and removing the epidermal crusts by means of poultices and washing; next the removing of the favi, which bear millions of spores; preventing at the same time the reproduction of these spores by parasiticidal remedies (such as solutions or ointments of metallic salts, as of acetate or sulphate of copper or iron, acetate of lead, calomel, corrosive sublimate, iodide of sulphur, liver of sulphur, black oxide of manganese, charcoal, &c.), and by wearing a wax cap; and finally removing the convalescent from the neighbourhood of persons who are yet infected with favi, otherwise frequent relapses occur. Especial care requires to be taken in order to prevent the head-dress of favous people from being worn by convalescents or healthy persons without its having been cleansed previously.

Bazin specifies the treatment as follows :

Internal remedies.—Purgatives and specifics have been generally abandoned, and strengthening remedies, such as improve the constitution, are now almost exclusively adopted.

Local treatment.

Epilation.—The only really successful remedy. 1. The oldest *method* of *epilation* is that of the *Jew's nightcap.* In this case

the removal of the hair is effected by means of sticking plasters, a method which has justly fallen into discredit, on account of its barbarism, and, after all, the uncertainty of success.

2. *Epilation by means of a pair of pincers,* according to the plan of Samuel Plumbe.

3. *Epilation by means of combs and fingers,* according to the brothers Mahon, after having rubbed the hairy parts with certain ointments (studiously held secret), with the ball of the thumb. The hair was torn out with the fingers, as the feathers of geese are when stripped. On the whole this is a method little to be recommended.

4. *Epilation produced by the disease itself,* which is the best means, according to Bazin.

The ordinary epilatory means act only mechanically on the hair-bulbs, not chemically; they act the better, and excite the more, the coarser the remedies are powdered. Mahon's ointments are therefore not more efficient than those made of powdered charcoal, chalk, or fullers' earth. Liver of sulphur exerts the most powerful chemical action on the hair; as even dead bodies, exposed to the air, lose their hair after being treated for twelve hours with it, whilst, however, the inter-cutaneous part of the hair remains unaltered.

If the favus be fresh, and if the hairs resist the attempts to remove them by means of a pair of pincers, they require to be rubbed for several days with an alkaline ointment (according to Bazin, with "chaux vive, soude du commerce, au 2 grammes; axonge, 60 grammes"), or also with a small addition of auripigmentum, or the oil of the acajou-nut ($\frac{1}{2}$ — 1 gramme to 30 grammes of fat), or, what I consider to be better, with "huile de cade." The latter keeps alive the sensibility of the parts of the head covered with hair, and acts more especially on the bulbs of the hair. Epilation effected by such means removes the hairs and their capsules, but there still remain spores of the parasite in the follicles. Epilation alone would therefore give but very uncertain results, and not be sufficient, or, perhaps, produce a merely momentary relief, whilst it does not prevent relapses. Even the method of the brothers Mahon did not prevent them, or they were only successful after treatment for six, twelve, or eighteen months. The brothers Mahon have chiefly been blamed for having purposely confounded favi with eczema, lichen, or psoriasis, and, more particularly, *Porrigo scutulata* with *Porrigo*

favosa, and for having announced that, on a general estimate, *Porrigo scutulata* was more easily cured, which latter statement Bazin's experience does not bear out.

The treatment, according to various writers, is as follows:

The head is first to be cleansed; the crusts are removed by cutting off the hair quite close, and by immersing the head several times in tepid water, and softening the crusts by washing, or by means of poultices (which, according to Lebert, are best made with the aid of a spatula), because the spores are less liable to spread over the whole head covered with hair, than in the case where baths and lotions are employed (a course to be recommended only in the case of restricted favus, and when a second epilation, after the appearance of scabs of favi, has become necessary, which course, however, is objectionable on account of the increased pain when the favus has once spread very much). The hair is then freed from lice (if there should be any) by means of mercurial ointment. Gudden, whose chief indication of a successful treatment consists likewise in the removal of the parasites, chooses remedies which destroy vegetable life without irritating the cutis to a great degree, when rubbed into the capillary depressions, and which cause no further inconvenience on being resorbed. Gudden, however, knows, as it appears, of no such remedy, for he was even unsuccessful with oil of turpentine. Gudden considers epilation, or, more correctly, the tearing out of the sheath of the root of the hair, as the principal requirement, and prepares consequently for it in the following manner: The hair is cut off, leaving it only a few lines in length, and the scabs removed, during one or two sittings, by the repeated application of warm soap-baths, and by using a soft brush, together with a round writing-quill, if necessary, whilst at the same time the softening of the parts, by applying the oily unctions recommended by Von Hebra, is to be avoided during the following treatment with water. As soon as the skin which has thus been cleansed has, to some extent, become covered again with a new epidermis, it is rubbed with equal parts of croton and olive oil before going to bed, and the parts which have been spared by the fungus secured from its ravages by strips of sticking plaster. The places are carefully examined on the following morning, and rubbed again with a little oil in case the very rapidly produced but also very painful inflammation should be too feeble, and the patient is to wear a double cap of linen, filled with a warm poultice made of oil and

rye-flour. The epidermis becomes softened in two days, the formation of cells in the outer sheath of the root of the hair is accelerated, and epilation and separation of the hair may be proceeded with by means of a broad pair of pincers—an operation which requires frequently a whole day when the favi are plentiful, and is very tiresome and harassing to the operator, who is often haunted by the disgusting sight for some days, in consequence of the strain on the eyes. The result is favorable. The fungus luxuriates at first among the purulent mass, which, however, dries up rapidly, and after the lapse of twenty-four to forty-eight hours lamellæ of suffocated fungi may be taken off, the epidermis is rendered healthy in a few days, and peels off only very slightly. The fine atrophied milk-hairs require to be looked to for a fortnight longer, and it is well to treat the skin with rectified spirit or ether, since these penetrate easily to the vegetable spores, and decompose them. Complications alone require some care. A rapid cure need not be feared, since there cannot be a relapse, in the proper sense of the word, similar to itch. Bazin also is unable to cure without the indication of epilation; he says—"The fear of permanently destroying the growth of the hair after epilation is unfounded, and it is not necessary to tear out the hair merely on the places which appear red and swollen, and covered with crusts, for the hair thrives always again on the diseased or healthy parts, even after applying these remedies." The hair is therefore removed not only from the diseased parts, but also from the healthy surrounding part, and even from the whole head in case porrigo has spread sporadically all over the head. No tuft of hair is to be left over the forehead or on the scalp of the head. It is sufficient after the first epilation to wash the head for three or four days, night and morning, with a solution of corrosive sublimate, to rub it with lard on the next day, or still better, with an ointment of acetate of copper (1 part to 500 parts of lard). If an eruption of pustules should occur, it is simply necessary to pierce the pustule, and to empty it of its contents. Careful treatment will cure the disease in six to eight weeks. The three forms of the favus—*urceolaris, scutiformis,* and *squarrosus*—agree in their origin, and require, according to Bazin, only *one* treatment. The *urceolaris,* thought to be the most intractable, is the easiest to be cured; and it must be considered as the first sign of a successful treatment of confluent favi, when the favus is isolated by becoming *Favus urceolaris.*

Sometimes there is seen an epidermal secretion on the places occupied by favi, such as is the case with pityriasis, which, however, need not cause any anxiety, and which disappears easily after washing with water and applying lard.

Treatment by Hebra.—He thinks *Herpes tonsurans* and *Favus* to be identical, and believes that the disease may get well spontaneously, and, with more reason, that no cure is possible without epilation. To produce the latter by means of the Jew's nightcap is, unfortunately, too painful, though the result might well justify such barbarism.

It appears to me that the principal task in an efficient treatment consists in finding out the mildest method of epilation. The arrangement which Hebra made in his clinical hospital (and which exists still, I believe), that diseased children should tear out one another's hair, is, no doubt, very recommendable, and saves time to the physician—a sacrifice which Gudden was not afraid of making. Some believe that the disease may be cured by drenching the head underneath a spout of rain-water. Cures without epilation are tedious, insufficient, and little reliable. This method would, I believe, deserve more consideration if it were preceded by epilation; and the nature of the disease might render the following treatment very useful. The hairs are to be torn out on the favous parts, and a lukewarm "douche" allowed to fall, for ten to fifteen minutes, on the child in a warm bath. In case of relapses, epilation is resorted to, followed by the douche. In private dwellings, where it is inconvenient to make space for a douche-apparatus, a watering-pot, or simple syringe of large size, may be used instead, provided with the fine sieve of a watering-pot, fitting well, such as is used in watering hothouse plants. If the operator has merely to do with very small spots of favi, he may conveniently use syringes with a round beak, such as are employed in diseases of the eye, and which may be bought from Jerak, at Prague, and at other places.

Treatment of Boeck, of Christiania (Günsburg's 'Zeitschrift,' v, 1, p. 50).—Boeck also acknowledges that the Jew's nightcap answers its purpose, but he considers the action thereof too violent, for it often happens that the forcible removal of a large pitch-plaster removes far more than the mere hair—a process which is therefore as dangerous as it is painful. This may, however, be modified by covering the head with eight to ten cuneiform pieces of a very efficient sticking-plaster, the

points of which meet towards the top of the head. Baume's ammoniacal plaster has been found most advantageous for this purpose. It is prepared by mixing in a porcelain basin, one part of gum ammoniacum and three parts of white-wine vinegar, and which is heated to boiling, then filtered, and two more parts of vinegar added to the solid residue; the mass is again boiled and filtered, and the filtrate added to the first portion, and allowed to stand for some time, in order to allow foreign bodies to separate and precipitate; the liquid is skimmed off and evaporated at a low temperature, to a syrupy consistence. The strips are covered with this mass, and put on the clean head by means of poultices, or *Linimentum Calcis*. After two or three days these strips are removed, either all at once, or on alternate days, when the patient is irritable. Many hairs are thus torn out, the skin of the head becomes inflamed, and a great number of pustules usually break out during the following two days, when the head has to be kept uncovered. These pustules are not identical with the favus. When the head is quite bald the ammoniacal plaster is less effective, since, probably, in consequence of a secretion of the skin of the head, the plaster is prevented from sticking so well. Recourse must be had to a plaster of *Pix burgundica*, *Acetum vini*, and *Amylon*, or to the following mixture: ℞ Colophon. ℥v, Olei ℥j, Ceræ albæ ℥ss; or ℞ Resina flavæ ℥j, Amylon ℥ss, Acet. vini ʒvj, Ol. oliv. ʒiv, Terebinth. ʒss. This process of sticking on and tearing off the plaster must be repeated for several months, at short intervals. The microscope alone can tell when the cure is effected, that is, when all the spores of the fungus have disappeared, or else there will be new crusts of favi, sometimes after a few weeks only.

Von Bärensprung ('Deutsche Klinik,' No. 6, 1855) employs likewise this modified pitch-cap, and orders precipitate-ointment to be rubbed in, in order to prevent the reappearance of the fungus.

Boeck tells us that it is one of the injunctions of the founder of the Hospital of St. Gallicano, at Rome, to treat the favus by scarifying the skin of the head; which was therefore done extensively every day, till the whole head had become scarified in the course of a week. The hair is not sacrificed in this process, and one may even succeed in splitting the follicle of the hair, amounting, in reality, to the extraction of the hair (epilation). This treatment is, however, admitted by the physicians of the hospital

to be slow (eight to twelve months); and Boeck did not observe any improvement after several months during which he made use of this method—hence his working out a new method. The results would, perhaps, be different if scarification were resorted to simultaneously with and after bathing with parasiticidal remedies. I believe that the deed of foundation, which requires that the donations of the hospital should pass over to other institutions if curing by scarification were deviated from, might be eluded by adding douche-baths to scarification.

Didot recommended quite lately preparations of tannin. Solutions of tannin should, at all events, be employed after epilation, without which it would be useless.

Appendix.

Experiments made on the growth and contagiousness of the favi by Remak and others.

The spores of fresh and dried scabs were found to germinate on slices of an apple. After twenty-four hours the sporidia exhibited short, pale, homogeneous, cylindrical outgrowths, which grew longer and more transparent during the following days, and became limited by pale outlines, whilst they themselves remained dark at those places which did not present any outgrowth. Small oval cavities were observed on the third and fourth days in the outgrowths, not separated by partition walls, which increased in size during the following days. On the sixth day observation became suspended by the luxuriant growth of the *Penicillium glaucum*, or some other species of mould, which covered entirely the favus-fungus, and, perhaps, their development was altogether stopped by the decomposition of the masses of fungi in consequence of the chemical alteration of the soil. The sporidia of the favus-fungus differ essentially from the simultaneously occurring spores of *Penicillium* and other fungi, in that they represent a many (three or four) sided germination. The spores of the favus-fungus germinate also in solution of sugar, but produce only thallus-threads, and no sporidia-filaments. The latter are formed when the sporidia are exposed to the action of the atmosphere. The mass of scabs crumbles in spring and distilled water without germinating. The spores do not germinate in blood-serum, solution of the white of an egg, muscle, brain, on severed pieces of the skin of man and animals, or on animal fats. They germinated speedily, however,

when solution of sugar was added or poured over them, when mildew rapidly grew over the Achorion, just as other mould-spores germinate speedily on apples and in sugar. When muscle or brain were immersed in water putrefaction was seen to set in, and infusoria were forming, but the action was stopped on addition of solution of sugar, and conferva and mildew were then observed to grow.

No infection resulted from the scabs of favi in case of fresh wounds, or small pimples scratched open; the scabs crumbled to pieces. Fuchs asserted that favus was more easily transferred on the uninjured skin. Remak attached, in May, 1842, small scabs of favi on the skin of his arm by means of sticking plaster; the scabs dried up and shrank, and fell off after a few days without leaving a trace of their existence. He washed his arm, and took a bath; but after the lapse of a fortnight he felt itching at the place of inoculation. He noticed a dark-red spot, covered with epidermal scales, the skin being thick and hardened. From the centre of the red spot there grew a pustule, and the remaining scab frequently secreted purulent matter. After three weeks from the first appearance of the spot, Remak removed the purulent scab, together with the pus, and found below a whitish body sunk cup-like into the corium, and consisting of nothing but favus-fungi, which formed a real favus-scab after a week. In another week a drop of pus began to make its way from underneath it, then ceased again, in order to drop again at times, and after four weeks the dry favus-scab fell off, measuring 4‴ in diameter, and the skin became covered with epidermis.

Contribution to the history of the favus.—Schoenlein was the first to discover the vegetable nature of the favi, and to make a drawing of the filaments of the mycelium and the granulated stroma. Remak had noticed mouldy filaments in 1837, but did not pay any further attention to them. He made the first attempts towards inoculation, believing the fungus was only able to live on a cachectic soil, and opposing the view of Henle, who thought that the fungus was accidental. Fuchs, Jahn, and Langenbeck discovered the fungus, but viewed it as an attribute of scrofulous rashes, more especially of exanthemata and serpiginous crusts. Gruby first described accurately the filaments and spores, as well as their penetrating the bulbs of the hairs: he inoculated the fungus successfully even on wood, and all his statements have been confirmed by Bennett, the latter believing, however, a scrofulous state to be indispensable. Hannover

confounded the spores of this fungus with *Cryptococcus Cerevisia;*" Müller, Retzius, Remak, Link, and Lebert, to whom we are chiefly indebted for a more correct knowledge of this fungus, classified it with *Oidium;* Vogel described it superficially; Rayer and Montagne knew it well, whilst Leveillé could not discover it; Mahon considered the disease to be a hypertrophy of the follicle of the hair, and thought that the hair was piercing the sebaceous follicles; Cazenave and Didot view the favus as an inflammatory disease of the follicle, and deny, on that account, the fungus and the parasitical nature of the disease, because Brett thought he had noticed the favus to occur after great mental excitement, owing to moral influences. Bazin must be looked upon as the most complete observer of this fungus among modern writers, though his illustrations are faulty, since they confound the sebaceous follicles with the fat-glands, not allowing that the latter opened into the follicle, and, moreover, thought they were sudorific glands.

Literature.—Schoenlein, 'Zur Pathologie der Impetigines;' Müller's 'Archiv,' 1838, p. 82, tab. iii, fig. 5; Remak, in 'Medicin. Zeitung,' herausgegeben vom Vereine fur Heilkunde in Preussen, Berlin, 1840, No. 16, pp. 73, 74; Valentin's 'Repertorium,' 1841, vi, p. 58; 'Medicinische Vereinszeitung,' 1842, und 'Beiträge zur gesammten Natur- und Heilkunde,' Prag, 1842, p. 893; in 'Diagnost. und pathol. Untersuchungen,' 1845; 'Muscardine und Favus,' pp. 193—215; 'Pilze der Mundhöhle und des Darmkanals,' pp. 221—227; Fuchs and Langenbeck, Holscher's 'Hannoversche Annalen,' 1840, in the Report upon the Göttingen Poliklinik; Fuchs, 'Die krankhaften Veränderungen der Haut,' Göttingen, 1842; Klencke, in 'Neue physiolog. Abhandlungen,' 1842, p. 60; B. Langenbeck, 'Bericht über die 18 Versammlung der Gesellschaft deutscher Naturforscher und Aerzte zu Erlangen,' Sept., 1840, von Leopoldt aud Stromeyer, Erlangen, 1841, pp. 166, 167; Jahn, 'Naturgesch. der Schönlein'schen Binnen-Ausschläge oder Exantheme,' 1840, p. 155; Gruby, 'Compt. rend.,' 1841, xiii, pp. 72, 309, and 388; also Müller's 'Archiv,' 1842, p. 22; Textor, 'Compt. rend.,' 1841, tab. xiii, p. 220; Meynier, *ibid.*, 1841, xiii, p. 309, note; Hannover, Müller's 'Archiv,' 1842, pp. 281—295, tab. xv, figs. 7, 8, 9; Bennett, On the vegetable nature of *Tinea favosa,* in 'Monthly Journal of Med. Science,' 1842, and 'Transact. of the Royal Soc. of Edinburgh,' 1842, vol. xv, 2d part, pp. 277—294; Müller

and Retzius, in Müller's 'Archiv,' 1842, p. 192, tabs. viii, ix; Cazenave, 'Dictionnaire de Médec.,' 1844, 2d edition, vol. xxix, article Teigne, p. 338, and 'Traité des Maladies du Cuir chevelu,' Paris, 1850, p. 210 sq. 220; Lebert, 'Physiologie pathologique,' ii, 'Mémoire sur la Teigne,' Paris, 1845, pp. 477, 478, and 486; Vogel, 'Allg. pathol. Anatomie,' p. 383; Leveillé, 'Dict. univ. d'hist. natur.,' Paris, 1847, viii, p. 461; Canstatt's 'Handbuch der medicin. Klinik,' 4 Band; Rayer, 'Traité des Maladies de la Peau,' Paris, 1835, i, p. 697; Bazin, 'Recherches sur la nature et le traitement des Teignes,' Paris, 1853, with 3 plates, and Considérations générales sur les Teignes et leur traitement, 'Journ. des conn. méd.,' Févr. et Mars, 1853, pp. 241—305, und 'Gaz. hôp.,' No. 92, 1853, Des Teignes achromateuses; Didot, 'Bullet. de l'Ac. de Méd. de Bel.,' 1853, pp. 227—255, Discussion über Philippart de Tournay's Note in 'Bezug auf Behandlung des Favus;' Gudden, in Vierordt's 'Archiv,' xii, s. 244 sq. 1853; Hebra, 'Zeitschrift der Gesellschaft der Wiener Aerzte,' x, 7, p. 88, Juli, 1854.

VIII. *Oidium albicans*. Tab. IV, figs. 3—8.

Synon.: Schwämmchen; fungus = Champignon = Cryptogam of Aphthæ, Soor, Muguet, Thrush. Species, *Sporotrichi affinis;* Apthaphyte = Kuhn or Kahn. We shall find in the historical part how great a number of misinterpretations this disease has undergone, which represents the effects of this fungus. We will only remark that what is called Aphthæ and Muguet is nothing more than the effect of this fungus, and that these two names mark merely different stages of its development.

The Aphthæ = Alcola = Muguet, Millet, or Blanchet = i funghi or Afte = Asorro (lining, because the disease looks like white linings) = Sore = Sprouw = Soor, Kuhn, Schwämmchen = Trödske = Torsk, in English Thrush, is a disease of the mucous membrane, manifesting itself sometimes in the form of small points, rings, conical and semi-spherical elevations; sometimes, however, in the shape of large spots, and able to form even a compound membranous envelope. This envelope is originally of a milk- or pearl-white colour, passing into gray or yellowish when the disease is left to itself, or occurs in weaned children, but rarely assuming a darker colour in children, which happens only when a foreign colouring substance acts on it. The external

portion possesses a more or less soft cheese-like consistency, is more or less thick, from the density of the finest paper to half a line and more; it adheres firmer at first than after a little while, and finally peels off by itself, without injuring the continuity of the mucous membrane. It is found alone or simultaneously on the inner edge of the lips, where the mucous membrane begins, on the inner side of the cheek, on the gums and the palate, on the upper and lower surface of the tongue, in the throat, and in the œsophagus, down as far as the cardia. Its microscopic constituents and its cause are a peculiar fungus. (Berg.)

Genus—*Oidium* (Link): *Fila simplicia ramosa, minutissima, pellucida, in floccis aggregata, leviter intexta, articulata. Sporidia ex articulis secedentibus orta, simplicia, pellucida.*

Species—47, *Oidium albicans: Fila in cespitibus laxis, primo villosis, humidis, albis, dein sordide fulvis, vel fuscis, vel fusco-fulvis intertexta, intus leviter granulosa,* 0·004 *lata,* 0·050—0·600 *mm. longa. Sporidia plerumque rotunda, aut vix ovalia, ex articulis secedentibus orta, raro ovalia.*

Habitat: *In membrana mucosa oris, faucium, œsophagi, narium, in lacuminibus pharyngis senum, inter massas mucosas et epitheliosas ad ligamenta aryepiglottid.; in mucosa laryngis, in cicatricibus bronchiorum, rarissime ad anum, labra, pudenda et mammas lactantium. Præsertim in pueris, in adultis cachecticis, inprimis senilibus ad extremum vitæ tempus.*

The white external layer consists, according to Berg, of the condensed epithelium, in consequence of an enlargement of the epithelial cells, of the elements of the fungus, and of molecular proteïn-detritus. Reubold, however, states, that fibrinous cells, the proper elements of pseudo-membranes, are wanting, and that it contains only amorphous fibrin, exudation-cells, and, at times, also globules of pus. The parasitical vegetation and the epithelial enlargement extend at first only to the points of the small papillæ (at the tip of the tongue), and small white and isolated patches are perceived (Muguet discret.), which often escape observation. If, however, fewer papillæ are found on the seat of the disease, and if the whole surface is smoother, as is the case with the mucous membrane of the mouth, with the exception of the upper part of the tongue, the external covering appears in the shape of rings of ribands, which are intertwined, and of hemispherical elevations produced by the fungus. The more numerous these points and rings become, the more luxuriant

the epithelium and the fungus continue to grow, the more they will run together and form a continuous layer, which covers the whole mucous membrane and its cavities (Muguet confluent), formed partly through the natural combination of the epithelial cells, partly through the entanglement of the filaments of the fungus amongst themselves and with the epithelial cells. Epithelial cells are met with mixed with cross filaments, sometimes covered with adhering spores, sometimes not, exhibiting, moreover, a more or less thick mucus, together with molecular granulations. Some filaments are seen broken up. A little practice will enable the operator to recognise the fungus without the microscope, provided it exists in considerable quantity. The mucous membrane underneath is seen to glimmer through if the epithelium possesses its natural density and transparency. The surface becomes less transparent and white when the epithelium thickens, and is macerated by heterogeneous liquids (milk- or pearl-white colouring of the infected spots). This milky colour passes into a yellowish or green tint when the growth of the fungus and the plentiful formation of spores takes its uninterrupted course. A similar observation has been made with regard to the spores of other fungi. The other colours of the soor-layer will be entered into more especially when we are speaking of the colour of the thrush itself, and it will suffice to remark here that the white colour is more particularly attributable to the granulations in children in private families whose mouths are kept carefully clean.

The layers of the fungus have the following *position :* Upon the mucous membrane is found a dense layer of epithelium; the fungus covers entirely the edges of the epithelial cells on their free side; the aphthous layers (soor-plaques) thus formed are soft; they grow to a larger extent, and the more rapidly, the more lacerated the tongue is, and the more numerous and larger the papillæ of the tongue are. The firmer the epithelium is seated on the tongue, the deeper they penetrate into the cells, which usually contain the roots of the fungus, whilst the filaments and branches make their way to the open air, the firmer will be their original footing. But if the epithelial layer becomes loose, after a little time, the fungus, together with the normally loosened epithelium, separates in smaller or larger membranous patches. This separation seems to proceed quicker when the renewed growth and separation of the epithelium itself is unna-

turally hastened on. The fungus can easily be removed artificially, without this normal separation, by scratching it off, or by applying linen compresses; less easily, however, by means of a pair of pincers. The mucous membrane is found to be inflamed, but not very red, when the membrane has been removed to some extent. It is the redder, the thinner the layer of epithelium is which covers it. A layer of epithelium would always cover the places from which the membrane is removed, if suppuration and ulceration were not brought on by delay; hence no blood appears when the membrane is taken off. This separation leaves always behind a few sporidia and filaments, which foster the renewed growth of the fungus as long as the soil is found to be favorable to its regeneration; hence the pertinacity of the disease. The opinion has now been generally accepted, that alkalinity, as well as the formation of lactic acid, are in its favour; but large quantities of either will prevent its growth. The mucous membrane of the mouth and the upper portion of the intestinal tube are its seat. Berg thinks it possible that the real fungi might thrive even on the mucous membrane of the genitals. No doubt, hæmorrhagic erosion in the stomach, or follicular affections and ulceration in the child's intestine, may have sometimes been called aphthæ. Some observers even doubt its occurrence on the nipples of nurses. The description of the fungus itself we shall give according to Berg, Robin, and Reubold.

The parasite consists of tubular filaments bearing spores, and of spherical or at first oval spores, which are the same everywhere.

1. The *tubular filaments* (*radices, trunci, fibrilli,*) of writers are cylindrical, elongated, straight or curved in different directions, 0·003—5 mm. broad and 0·05—6 long, rarely longer or broader. Their edges are dark, accurately defined, and mostly parallel. The interior of the tube is transparent, and of an amber colour. The filaments are formed of long cells, with occasionally articulated cells which are 0·002 mm. long; they decrease in length towards the free end, which bears spores, and are, when washed out, seen to be once or more times ramified, and the branches composed of cells. The latter are often as long or longer than the branches; sometimes only one short and round, or two or three elongated cells, are perceived in them. Partition walls are met with from time to time on the branches and filaments, and diminutions or depressions on

a level with them, on or below which the branches occur, which never communicate with the cellular cavity. Robin supposes the partition walls to have been produced by the gradual approach of the roundish ends of two cells. The cellular cavities, closed by the partition walls, contain usually some molecular bodies, from 0·001—2 mm. in extent, which are of dark colour, and which move about; or, instead of these, little bodies of from two to four oval cells, with pale-yellowish cellules, which are more brilliant and less dark than the filaments, closely approaching with their ends, or becoming a little depressed, and possessing homogeneous transparent contents. The end by which they are attached is usually hidden in the centre of a heap of isolated spores, which are sometimes mingled with epithelial cells. By isolating these formations the first cell is found to be a prolongation of the spore, and a free communication exists between its cavities, whether the spore be formed by many cells bearing already branches, or merely be represented by one or two cellular cavities. This spore incloses usually two or three spherical, dark granules, 0·001 mm. large, with sharp edges, and a distinct motion in the interior. Other spores are often attached very firmly to the germinating spores. The free end of the filaments or of their branches, as well as the end which bears spores, are round, without enlargement, or it is formed by a spherical or ovoid cell, which is larger than the preceding, and separated by a distinct process of contraction into one or two smaller cells. The last cell is 0·005—7 mm. large; the paler cells are probably only just formed; the riper, however, are probably spores ready to separate. When the cells are ovoid or short, the filament acquires a various or twisted appearance which precedes the final swelling.

2. The *spores* are spherical, or a little longish, with distinct dark edges, and a somewhat more transparent amber-coloured cavity, which refracts the light strongly, and contains a fine molecular dust, or one or two globules 0·0006—0·0005 m. in diameter. They are seldom placed in rows of from two to four. A part freely floats, but the greater part are attached to the surface of the epithelial cells of the mucous membrane of the mouth, in the form of a dense heap. Only when they are met with in separate masses is it sometimes possible to recognise their edges, and the spores are often seen heaped up in round groups. They are easily distinguished from the globules of milk, the granules of starch, the cells of mucus and epithelium, in connection with which they are

apt to appear, by their peculiar mode of occurrence, for the most part, in groups of two. Both spores and filaments resist even concentrated sulphuric and nitric acid. The fresh fungi are shorter, not ramified, the partition walls are closer together, the contractions rarer, the filaments more regularly cylindrical, and the contents of the terminal cells of the filaments paler. The same may be observed in algæ which have been kept in water for several days. Reubold observes that, on the whole, little is to be added to this description as given by Robin. He also speaks of the spores and of the partition walls and the contractions, rarely found on any fungus of the skin, as well as of the oval violet-coloured cavities, as highly characteristic of this fungus, although they are sometimes small in number. Reubold deviates from Robin merely in assuming the existence of two kinds of germination in the spores.

Threads of various thickness, with partition walls and contractions whence the branches arise, spring from the ends or sides of the spores, whilst in their interior granules and molecules are found. The filaments betoken their origin, according to the position of the spores, sometimes as shining points, sometimes as projections. Very thin threads frequently originate during the germination, which are often of considerable length, and without any partition walls or contractions, exhibiting only numerous dense cavities, which, however, finally expand. Robin does not seem to be aware of this kind of development, whilst he knew well the second kind, where the fungus is developed by mere prolongation of the spore, and direct transformation into threads. The spore becomes longer during this process; the cavity remains the same, whilst the prolongation may give rise to a new cavity, or frequently to two, three, or four, side by side, beginning as small points. These spaces enlarge as the cell enlarges and elongates; they touch one another, and finally leave only small partition walls between them, so as to transform these partitions not into new formations, as Robin states, but into the remains of a previous solidity. The same formation of expanding hollow spaces occurs during germination; the two kinds of development are sometimes met with during the same germination. The ramifications, which have the same diameter as the principal trunks, are for the most part only perceptible in the first order; ramifications of the second, third, and fourth order are, however, often found. Very neat dendritical figures occasionally occur.

The branches incline at various but always rather sharp angles, so as to impart to the whole *the appearance of a tree with its branches*—a good criterion for our fungus. Regularity in the number, the position, and the alternation of the branches does not exist. Special organs for proliferation were not noticed (Reubold); it is, however, probable that the swellings and cells at the ends of the filaments and branches are transformed into spores. Objects are often seen which must be viewed as transitions from simple enlargements to distinct separate cells, which sit sometimes looser, sometimes firmer. Robin noticed the same on other fungi. It is not to be doubted that the organs for forming spores are less distinct here than is the case with other lower fungi.

Colour of the Thrush.—It is mostly white, like coagulated milk (*lactucimen*), sometimes dirty, yellowish, brownish, and even blackish; the aphthæ are never of a pure white. The white colour of the thrush results partly from the fungus, partly from epithelial accumulations; at all events all epithelial sloughs in the case of hypertrophies of glands and on other places, in the case of measles, stomatitis, &c., are of the same colour, even if there be only single layers. In private families where children are fed well and acquire habits of cleanliness, this whitish colour remains usually the prevailing colour, and it turns more yellow only when the fungus is allowed to expand into large membranous masses. Whence the dirty and brown colour comes from it is difficult to say. Reubold thinks that it is only met with in the membranous form, and agrees with Berg, Valleix, and Robin, that it lies in the fungus itself, and in the colouring of its spores which occur in such large quantities, and that it is not caused by any extraneous colouring substances. The great formation of spores, or the dismemberment of the epithelium, which turns yellow, may either perhaps cause this colour; perhaps, also, the age of the spores. One is reminded of the white colour of the boletus in its early stage of growth, and of its brown colour when old. The thrush-fungus lastly turns brown on drying. The still darker, blackish-brown and black colour is the result of coloured substances used as medicines, blood, pus, or of the complication with the ulcers of the mucous membrane (Berg).

Seat of Thrush according to Reubold.—The thrush-membrane is siad to lie sometimes under the epithelium, sometimes leaving the glands quite free, or proceeding from them, or sometimes

only luxuriating in the mucus of the mucous membrane. Lélut even states that it occupies at different periods of its development different positions; at first being underneath the epithelium, and after a little while laid bare. The soor is seen with the naked eye, at least, for a short time, below the level of the surrounding epithelium, but never directly on the mucous membrane, but always on epithelial layers; nor does it exclusively proceed from the glands, since the free glandless edge of the lips, and the upper surface of the nearer glandless part of the tongue, are most frequently attacked. The fungus is always seen to be intimately mixed with the epithelium; the former is found between the epithelial cells, penetrating all their layers, and mixed up with them. It cannot be said with certainty where the epithelium allows the fungus to penetrate its outer layers; this seems, however, to be the case in several places, and especially where inequalities in the thickness of the layers and in the separation of the epithelium occur.

The fungus, in growing amongst the epithelial layers, attacks first the uppermost layers, growing gradually also among the lower, whilst the uppermost are worn out and thrown off by the rapid growth from below. The fungus attaches itself with its filaments partly to the epithelium, partly in the furrows of the surface of the tongue, and all around the papillæ, which sit like a red centre in the thrush-ring. It occurs very rarely, according to Bednar and Robin, on the mucous membrane, with ciliated and cylindrical epithelium, but especially on that which contains pavement epithelium, perhaps on account of their stratification, and the possibility of an increased development of cells. It likewise occurs only where there is pavement epithelium in the respiratory passages. Reubold observed such a case in the nose of a child two months old, and repeatedly in children on the aryteno-epiglottic folds, and in the larynx, and on the vocal ligaments. It is slightly distributed over the bronchi and the larynx. It may, however, spread when cicatrized ulcers are found on those parts of the body which are usually accompanied by pavement epithelium. The epithelial appendages which the glands of the mouth offer at their openings are likewise a favorable place. The fungus is often attached at first to the openings of the glands, and penetrates laterally underneath the epithelium. The secretion-layer of the mucous membrane is not very favorable to its development, on account of its growth and its distance

from the proper mucous membrane. Robin is of opinion that the fungus grows in the layers of the mucus which are attached to the epithelium, and on the surface of the latter; an opinion which was refuted by Reubold. The mucous membrane is rarely altered by the fungus, although it penetrates down below the first epithelial layer, sometimes even into it, which leads to its softening and ulceration, occurring especially on the alveolar edge of the skin, when the fungous layers have been forcibly torn off. It is as yet undecided, it seems, whether the fungi cannot live on those places, or whether they thrive but sparingly, where there is ciliated epithelium, although there seems to be no further doubt that those tissues greatly favour the growth of the fungus, which are covered with pavement epithelium. Berg states, that this fungus does not occur around the rectum and nates, and on the nipple, but thinks that it may occur on the mucous membrane of the genitals. Berg was chiefly led to this statement by his theoretical speculations, and the former is therefore not yet decided. Further and final practical observations will be required, which demand great care on account of this disease being easily confounded with hæmorrhagic erosions of the stomach, follicular affections, and ulceration of the intestinal tube in children, or with undigested coagulated milk.

Circumstances favorable to the development of the thrush-fungus, according to Reubold.—This fungus is found at every age, the earliest as well as the oldest in preference, the reason of which may, perhaps, be sought in the long sleep of very young and of aged persons, leaving to the spores time for growth without disturbance. Reubold observed it on persons from the age of two days to seventy years, more especially, however, up to the first nine months, frequently in connection with catarrh of the bowels, from whatever cause produced. The conditions under which the fungus thrives are little known. Secretory changes of the mucous membrane (production of an acid secretion, particularly of lactic acid), induced and fed by the fungus, (Robin); next to this a changed vegetation of the epithelium play still a considerable part in the theory of the genesis of the fungus. Such opinions are not fully proved yet. It is true that the thrush-fungus, like the other fungi, is found to follow a decomposition which provides for its wants, increasing it even by the eagerness with which it abstracts nourishment. Decomposition of organic, especially nitrogenous, substances, such as takes place in the

mouth, acts, no doubt, favorably (Robin), but a decidedly acid decomposition and formation of lactic acid is not necessarily required, for thrush-fungi are found without any acid reaction. Among the causal circumstances, the peculiar properties of the mucous membrane are especially not to be passed over silently; such as its loose state, its unevenness on the surface, and its readiness to cast off its epithelial cells,—conditions which, like the separation of the membrane of the tongue, are of transient, but frequent, occurrence in the mouth. Add to that the repose of the mucous membrane in question, which is the more conducive to implantation the greater it is; next the lessened moisture and occasional drying up of the mucous membrane, as often happens in the upper parts of the intestinal tube, and the stratification of the epithelium, which prepares the way for the fungus the better the more abundant it is. Thrush is therefore met with most frequently and remains longest on those places of the mucous membrane of the mouth which possess the thickest epithelium—on the hard palate, accordingly, behind and on the inner part of the lips and cheeks. The papillary bodies of the mucous membrane appear likewise to stand in a certain relation to the thrush-fungus, for the latter seems to have a liking for the places where the papillæ are thickest, such as on the hard palate, on the cheeks, the lips, on the back of the tongue, and on the œsophagus, though the fungus occurs sometimes in the larynx, where these papillæ, are not found.

The properties of the epithelium seem mostly to deserve our attention. Several questions must, at present, be left unanswered, as to whether the coherence of the epithelial cells be at first increased and afterwards decreased; whether the thrush-membrane falls off at a later period; whether the earlier irregularity in the epithelium, which facilitated the growth of the fungus, be equalised; whether the later epithelial crop thrives more rapidly than the fungus itself, or whether the secretion, which is at first viscous, loses afterwards its viscosity.

Catarrh is, of all diseases of the mucous membrane, that which offers the above-mentioned undoubted causes of aphthæ most abundantly, presenting them all, whether they be of a mere mechanical, local, or constitutional origin, acute or chronic. It causes, at all events, changes in the arrangement of the epithelium and in its secretions, if only because it is likely to lay bare the secerning mucous membrane. Those changes which

the epithelium undergoes by a catarrh are unfortunately little known as yet, and just as little do we know correctly the nature of the secessions of secretion. One would naturally expect that the eruption of the thrush-fungus should always be preceded by distinct indications of catarrh, as was stated by Billard, Lélut, Valleix, Empis, and Gubler, who supposed the mucous membrane to be more or less inflamed, and yet these symptoms of inflammation are so few and so indefinite, as was already stated by Robin, that they can scarcely be recognised. There are, however, indications of such a state of irritation, although very local, such as a local stomatitis, and the formation of a more abundant epithelium on such places (Berg, Bednar, Reubold *Stomatitis morbillosa*). We may, moreover, mention those symptoms which point to a catarrhal state of remote portions of the bowels, or to general diseases of the blood (*typhus, phthisis, phlebitides, lymphangitides, &c.*); such as, diarrhœa, vomiting with pain, fever, *erythema podicis*, though Bednar thinks that this is merely a complication with thrush. It must not be overlooked that the thrush sometimes disappears rapidly, sometimes remains stationary for a long time, and sometimes reappears; and it is well to observe in future, whether this change can be brought into accordance with changes observed in the catarrh. Let us not forget that the most favorable age is that of childhood. This age offers most facility on account of its irritable mucous membrane, so rich in blood, and which seems to react on the slightest indigestion, by producing diarrhœa, inflammation of the mucous membrane of the mouth, attended by dryness or pain, when children are seen lying with open mouth, their tongue scarcely moving; or by causing a general catarrh (*icterus*). Reubold noticed on himself the thrush-fungus, caused by a rheumatic inflammation of the neck, to which were added a catarrhal and a local irritation of the mucous membrane of the mouth, from taking rancid cod-liver oil, and saw it disappear again with the catarrh.

The occurrence of thrush around the nipples of mothers is explained by Robin, with Bouchut, Rayer, and Empis, according to his theory of acidification, as being caused by the retention and acidification on these places of the milk and the mucus of the child's mouth; and Rayer, Charco, Depaul, and Verneil, say they have noticed it on ulcers of the extremities, in consequence of protracted lying, in the case of severe phlebitis, a fact which

was, however, never observed by any modern writer, although it seems to me that the possibility of their occurrence is not to be excluded on physiological grounds. The horny tissues are closely related to the epithelial tissues, and only separated in their wider life the one from another. In a diseased state, nature is anxious to restore the epidermis which was just removed, and the formation of epithelial cells must therefore take place, which the fungus might occupy as its seat. Thus the growth of the thrush on the above places of the skin becomes intelligible. (See section XII, and what is stated there of the nail-fungus.) It has already been remarked that the thrush occurs occasionally on ulcerated surfaces and diphtheritic membranes; according to Robin, the elements of the fungus are, however, found on these places only in the purulent mucus of the diphtheritical ulcers, which fact he explains by the accumulation of the epithelial masses, especially of pavement epithelium in such exudations.

Berg thinks that the thrush-fungus grows also externally on the body, especially at a temperature of 30—35° C. (98° Fahr., blood-heat), and in albuminous liquids forming an acid; and is of opinion that its development outside of the body is divided into two different forms, now in the form of sporidia, giving rise to a mouldy membrane on the surface of the liquid, and then in a stalked form, exhibiting radiating and entangled fibres. Immediately afterwards, it is, however, stated by Berg, that he obtained a thrush-like mouldy membrane, in a liquid which contained a solution of milk-sugar and a piece of the stomach of a new-born child; likewise in a liquid of mucus and cane-sugar, although he could not discover any thrush-fungi, either in the stomach or in the mucus. The same occurred after some weeks in closed vessels in solutions of milk-sugar, made of human and cow's milk. Vegetations like the thrush-fungus became rapidly manifest in the serum of the blood, diluted a little with water and acid, more rapidly still when a little cane-sugar was added. Solution of caustic potash, which dissolves easily the protein-compounds, clearly proved the vegetable nature of the above formations. A similar process is noticed in milk, which seems to be accelerated by a mutual action between protein-compounds and certain acids. The thrush-fungus seems to be nothing more, according to these considerations, than a kind of fungus occurring as an ordinary mould on animal textures and animal liquids which are left uncovered, and the fungus nothing

more than a mould-fungus ejected from the living human body, but still adhering to the living filaments, and occurring on parts of the organism (epithelium); its elements never penetrating the real life-texture.

Berg very justly remarks that, properly speaking, there are no good or malignant fungi, but only a lesser or higher degree of the causal process of disease, in the course of which they become manifest, and that the symptoms which precede the outbreak of the fungi belong to diseases which cause a general disturbance of health, and facilitate at the same time the sowing of the fungi. These fungi may, therefore, be accessory to a great many different and serious diseases of children and grown-up people.

Effects of the Parasite on Man (*Reubold*).—The fungus being merely a symptom of a disease of the mucous membrane, as stated, does not deserve, according to Robin and Reubold, to be placed among the formations noxious to man, and deserves mention only on account of the increased difficulty experienced in swallowing and sucking by its accumulation, preventing, by means of obturation of the œsophagus, the passage of the food, and generating a considerable amount of acid by facilitating decomposition. Other symptoms which accompany it, such as diarrhœa, more rarely vomiting, erythema of the skin, and the saturated fever-urine, are not attributable to the thrush but to the catarrh. The fungus is, however, not quite so despicable as to be estimated in its effect merely as a furred tongue (Bednar), proof of which is found in the enormous masses of fungi which almost stop up the œsophagus. Its occurrence on the ligaments of the glottis may render it very dangerous, by stopping up the glottis and producing spasm or inflammation, and œdema of that organ. Reubold thinks that the ulcerations and erosions underneath the thrush-fungus ought to be accounted for by catarrh more than by the fungus, although the latter is able to change erosions into ulcerations, if it be correctly stated that it penetrates the mucous membrane. The frequent occurrence of thrush in dyspepsia is explained by Reubold and Rinecker by the fact that the fungus acts like a ferment on the mucous membrane of the stomach, thus causing, in a very short time, its softening, and even death may occur. Berg mentions, among its effects, the following: sometimes as precursors of an eruption of thrush: inflammation, pain, and heat of the mucous membrane

of the mouth, symptoms which frequently, in new-born babes, are of a mere physiological character, as well as external redness of skin, and which are often met with without being followed by an eruption of thrush-fungi; sometimes, however, a slight condensation and whitish colouring and swelling of the epithelium are noticed on the free edge of the lips, as if in consequence of a kind of maceration. A disturbed taste, in consequence of a luxuriant development of fungi, is occasionally observed, and may be considered often rather as the effect of a general catarrh, besides an interruption of the free movements of the affected parts. The renewal of the epithelium succeeds more rapidly than usual, no doubt with the aid of the fungus, although the gastric primary disease by itself favours this renewal. Berg seems to be justly of opinion that the fungus produces the hoarseness, which often accompanies thrush; and even the already existing vomiting might, to some degree, be increased by it, although the fungi do not necessarily cause it. The slight idiopathic form, affecting healthy children, is said by Berg to have precursors, yet the symptoms he mentions seem to be merely symptoms of a slight intestinal catarrh. The torpor and drowsiness accompanying such cases, as well as the fear of removing the diseased parts, are very likely the means of increasing the luxuriant growth of the fungus, for even sucking must necessarily disturb the attachments of the fungous parts. Night may, therefore, be in favour of eruptions, as well as the long sleep of the new-born child, according to the view of Berg and other writers.

I am inclined to attach little importance to the disturbing influence exercised by the confluent fungi on the secretion of saliva, which they almost prevent during the period of the earliest childhood, whilst it seems of more importance with well fed children, who require much saliva for the insalivation of their food. Berg observed, at the Foundling Hospital, in 1845, during the prevalence of aphthæ, that the fæces of 29 out of 139 children were yellow; of other 29 children, after the fungus had made its appearance, green; and of 57 the motions, sooner or later after the eruption, became of the same colour. Berg seems to conclude from these observations, that the thrush-fungus colours the fæces green; we are, however, unable to follow him in his deductions, and believe that the first 29 cases, with constant yellow motions, are quite sufficient to prove the view of Reubold

and others, and that the cause and the varying accident were confounded. The cause of the green feculent matter must be sought for in the catarrh of the intestines, the cavity of which likewise favours the growth of the fungus, and not *vice versa* in the luxuriant growth of the fungus. I have arrived at this conviction in spite of Berg's observations (l. c., p. 41 *et seq.*, of which I intend speaking more fully in the Appendix), which seem, on superficial examination, to favour his view. We arrive probably nearest the truth by making the allowance that the aphtha-fungus occurred at a later period than the catarrh of the intestine, and became the cause of sustaining the latter by its very presence, favouring to some extent the decomposition of certain aliments into lactic acid. Berg states that he never observed death as the immediate cause of the thrush-fungus; all he saw was contraction of the epithelium on the places above the cardia where the fungi adhered very strongly, and he assures us repeatedly that he never noticed underneath the cardia, or in the lungs, fungi which adhered closely, but only loose elements of a fungous nature. Berg thinks that the fungi were, no doubt, the cause of the earlier diseased symptoms, for the latter disappear and health is restored with the disappearance of the fungi. This phenomenon finds, however, its natural explanation by inverting the causes, and by saying: As soon as the disease which favoured the development of fungi is over, the latter will disappear, and it naturally follows that we have to ascribe more influence to the generation of the acid products of digestion than to the fungi. I shall return more fully to Berg's experiments, in order to enable everyone to judge for himself; I, for my part, think that the question is neither decided in favour of Berg, nor do I believe that Reubold and Robin (the latter seems not to have been aware of the existence of Berg's work) paid any such special attention to these experiments in treating of the question referred to, as they undoubtedly deserve, in spite of his defective and one-sided investigation of the subject. Although I cannot share Berg's view, I agree with him that it is not very improbable that the thrush-fungi, occurring in large masses, are able to create a tendency towards an increased acid digestion, if it were only because they pertinaciously retain the acid which is found to be present. The frequent occurrence of such a tendency may, however, be doubted, since the greater number of the cases where this fungus occurs are accompanied by

a great want of appetite and impaired digestion. It is lastly not to be overlooked that, although spores are present, they cannot thrive in an uncongenial medium, and that much depends upon the medium, and even the disease itself, as to whether it be able to create a favorable medium for itself or not. It is, however, possible, according to Berg's experiments (much as they require to be repeated), that the fungus itself is able to help to transform (if only to a slight degree) the soil upon which it grows into one more favorable for its growth. It is well known that the age of childhood is the period of diarrhœa, and since the latter occurs more frequently in summer, the summer diarrhœas of children are greatly in favour of this disease. Age, by itself, does not protect from it, neither does the climate. The growth of the fungus is, moreover, assisted when the spores of fungi fly about in large numbers in a place which is with difficulty ventilated, thus causing always fresh infection. Suckling does not afford unconditional protection, although, on the whole, fewer children nursed by their mothers or by nurses are subject to it than otherwise—a fact attributable more to external causes (such as the contagiousness of the disease), and to disturbances of the digestion, caused by the unnatural way in which they are reared, than to the quality of the food itself. Temper and sex of the child are of no influence at all. The principal circumstances, favorable or unfavorable, are supplied by the healthy or unhealthy state of the child. We know also that grown-up healthy people, as well as children, are liable to thrush.

It follows thus that the aphtha or thrush is owing to a fungus, and that it consequently is an entophite, and not an exanthem, and that this eruption is not of a critical nature. The latter may especially be said of the thrush around the anus of children, or of the thrush-crisis, as it is called. These phenomena are by no means real fungi, for nothing is seen of the fungus, but they are simply produced by the mechanical action of the acrid fæces of children. In the case of real thrush, the *Oidium albicans* becomes perceptible from the very beginning of the disease, and in the smallest spots and points (Berg, Reubold). Should it, however, happen that it cannot be discovered at once, as happened to Remak, it is merely necessary to treat the object with *kali causticum*. The fungus is accordingly no mere consequence or accident of a disease of the mucous membrane, but the cause of the disease itself.

No further argument is then required to prove that the thrush is a *contagious* disease, the spreading of which depends upon the transfer of the spores of a fungus, and we may easily understand the outbreak of it in large foundling hospitals. One means of its spreading is the suckling several children at the same breast; sucking-bottles, sugar-titties, and vessels in general which are used in feeding children in community; the very hands of the child, or the fingers of the nurse, especially when the latter has to attend several sick children, and presents them to the healthy children to suck at; the chewing of the food by mothers or nurses suffering from thrush; the toys of sick children which are sucked by healthy ones; unclean articles of dress, bedding, &c. Berg mentions also that artificial food, and especially the keeping of such close to mouldering liquids, is likely to become a means of transfer. The reasons for Berg's view will be found in the experiments mentioned at the end of this volume; these render it very likely that the thrush is a kind of mouldy fungus usually occurring on old protëin compounds exposed to the action of the air. It appears to me that a chief cause of the contagious nature of thrush in large foundling hospitals and lying-in hospitals, must be sought in the bath, and the vessels and things employed, such as sponges and linen for cleansing the mouths of children, and in the water itself used for bathing, in which the spores float about, and in which vessels are washed which may be used for water employed for cleansing the mouths of other children. In private practice the thrush is likely to be transferred by the objectionable custom of nurses, who have the charge of several children, bathing them at one time and place. These women are in the habit of cleansing the mouth of the child with their finger, either uncovered or wrapped in a rag of linen. If we consider, moreover, how chapped and rough the fingers of such women usually are, it will no longer remain doubtful that they may be the cause of spreading the spores of fungi in private practice. Berg proved the contagiousness of this disease by transferring the fungous layer on to the healthy mucous membrane of healthy children living in various localities, by the following experiment. He took some crusts of aphthæ from the mouth of a usually healthy child, which had suffered for four days from thrush, and placed them on the intact mucous membrane of four children brought to the foundling hospital the day before without a trace

of fungi, between the cheeks and the back part of the alveoli, because they would remain there longest.

1. One child whose parents were unknown, but which was suckled, exhibited, after sixty-five hours, distinct thrush on the tongue, which had formed on the eighth day a large confluent mass. Green stools were observed from the fourth to the eighth days, followed, on the eighth day, by vomiting, by a watery stool, and an increased difficulty in sucking. Careful local treatment removed the vomiting and diarrhœa; the thrush decreased, and disappeared entirely on the eleventh day. The child was again suckled, but the mucous membrane of the mouth was reddened and the papillæ swollen. For three weeks there were new eruptions.

2. Another child exhibited quite the same phenomena; the thrush-layer was already slightly developed on the fifth day. It persisted pertinaciously up to the eleventh or twelfth day, when it disappeared. In this case, also, diarrhœa was noticed on the fourth day.

3. A third child, suckled by its mother, exhibited on the fourth day slight traces of discreet thrush without disturbance of the health in general, and which soon disappeared by means of local treatment. Another child, suckled by the same mother, likewise exhibited thrush without being inoculated.

4. A fourth child, suckled by its mother, exhibited thrush on the fifth or sixth day; it remained white, discreet, and produced no special gastric symptoms.

These experiments prove, on the one hand, the contagiousness of the disease, and, on the other, that the fungi pass off quite mildly without any other gastric disturbances than those already existing, whilst they vegetate most luxuriantly in such cases. I am of opinion that the diarrhœa in the first and second cases is not to be placed to the account of the thrush-fungus, but to that of the change of the mother, and because the children had first to become accustomed to the milk of the new mother. It is thus clearly seen, that the cessation of sucking accelerates the spreading of the thrush; perhaps on account of the fact that the fungi are transported, during the progress of sucking, from the mouth to the intestine, which is less favorable to their development.

This shows clearly the injustice of finding fault with the nurses for a want of watchfulness, or with the sucking-bottle,

when an epidemic of thrush occurs, as has been done at the Leipsic Lying-in Hospital, on the part of the director of that institution. It is not the rude cleansing of the mouth on washing the children, nor the irritation caused by it, or even the exposure of the mucous membrane of the mouth, nor the irritation caused by sucking at a sucking-bottle, which are the causes of the thrush, since we know from Berg's experiments that the fungus thrives even when it is transferred to an intact mucous membrane, and also that it sends its roots only into the epithelium, and not below. Would it not be sufficient to employ great care and cleanliness in using the various vessels, especially the baths and their apparatus, when fungi have once declared themselves in the hospital, applying the usual reproofs when open neglect is discovered? Such a course, I think, would be more adapted to an institution which perhaps was the first in Germany where the vegetable nature of the Aphthæ was studied.

Prognosis.—There exists no prognosis of thrush, according to Reubold, this disease being in general of little importance, and only capable of producing independent symptoms which endanger life in the exceptional cases already referred to, either by their masses or by their seat. Berg is of opinion that they are quite indifferent in healthy persons, disappearing spontaneously, or being at least easily curable; and he says that he never witnessed a case where death ensued. The simple idiopathic, as well as the discreet forms which attack healthy children, are the least injurious, whilst the confluent, which occur in diseased conditions of the system, generally demand the prognosis of the original disease. In special cases, however, when the disease makes its appearance during severe illnesses, or when the exhausted bodily system would otherwise rapidly recover, they are certainly not to be slightly treated. They retard the return of the appetite by destroying the sense of taste, and render the appeasing the appetite less agreeable by increasing the difficulties of deglutition, and by thus rendering hunger endurable for a time by dint of self-control, when it would be extremely desirable that the exhausted body should recover rapidly by means of good food. They also retard convalescence, and are capable of reducing a weakened body to the uttermost. The colour is of no prognostic value at all, unless we consider the dark brown or black forms as more dangerous on account of their indicating an

original disease that depends upon a disordered condition of the blood (scorbutus, morbus maculosus Werlhoffii, &c.), or a more copious ulceration. The cure of thrush will remain an impossibility as long as the remedial agents do not succeed in removing the original disease and in changing the soil on which the fungi thrive.

After having thus studied this disease in all its forms, we now proceed to speak of the *differential diagnosis.* Following the very able historical and physical description by Berg, and viewing thrush and aphtha as synonymous, I give the differential diagnosis, with some modifications, according to Reubold :

1. *Stomatitis vesicularis.*—Distinct little vesicles, often arranged in regular groups, are perceived on the surface, at the top and on the edges of the tongue, especially in older infants, which sometimes heal rapidly, and sometimes pass into pustules or ulcerations. These vesicles, when they are still small and filled with a whitish-gray matter without reddening the surrounding mucous membrane, are not easily made out without the aid of the microscope. They are, however, easily distinguished when the vesicles are a little larger and surrounded by an inflamed ring, and filled with a larger mass of a clear transparent liquid, when they spring up discretely, or burst after a little while, presenting an ulcerated mass, covered with a dirty yellowish secretion. When the thrush lasts very long it becomes accompanied by ulcers, although the fungus is found to grow secondarily even in the colon and on diphtheritical exudations, which resemble it to some extent in colour. The thrush resembles at first crummy, gritty bits of cheese, or patches of coagulated milk, which look like the slough of ulcers ; the fungus itself supplies, however, the distinctive diagnosis.

2. *Certain affections of the epithelium of the mucous membrane, especially epithelial accumulations.*—They are very much like the patches of thrush. The chief distinction is found in a thicker and a shining layer of epithelium, and in their remaining stationary and unaltered for from four to six weeks, until they disappear at last. They are often met with, but always in an isolated state, and on the middle line of the hard palate, towards the front of the alveolar processes. They are likely to occur sometimes to a larger extent and in a higher degree, and I believe that the *Stomatitis morbillosa* of Reubold and the *Pityriasis*

oris are nothing more than such an epithelial productiveness on a larger scale.

3. *Stomatitis follicularis* occurs most frequently about the time of the first teething and in old age. Large, white, discrete, half-spherical or flat vesicles are formed especially on the lips, on the inner side of the cheek, and on the gums. These vesicles are depressed in the middle, often provided with a point; they burst soon, forming superficial ulcers with a red ring, and healing sometimes with and sometimes without cicatrization. Weak children are most subject to these ulcers, and in them they penetrate deeper, spread out more, possess a lardaceous base, and cause greater destruction. These vesicles are nothing more than the inflamed and enlarged mucous follicles.

4. It is not very likely that the thrush should be confounded with the fatty degeneration of the villi of the mucous membrane, especially near the cardia, observed by Reubold, which I stated often to occur normally in the intestinal canal of dogs, and which I regard as a sign of old age.

5. The *gastric fur of the tongue*, especially the spotted, and the *white masses around the teeth and gums*, as well as the *white coating* which often detaches itself irregularly on the fourth or fifth day from the tongue of children *taken ill with scarlatina*, are easily distinguished with the aid of the microscope and by the absence of the fungus. I was unable to discover the thrush-fungus in the latter, although I applied caustic potash.

6. *Remains of food and especially coagulated milk* are easily confounded without the microscope. Many of the cases mentioned by writers of thrush in the intestines and stomach, of thrush-layers passing off with the excrement, were probably nothing more than particles of such undigested coagulated milk. The microscope alone can throw light on this subject.

7. Ricord states that a certain syphilitic disease of the tongue, accompanied by granulated papillæ, resembles thrush very much.

Therapeutics.—Berg paid great attention to this point, and recommends finally the nitrate of silver (from x grs. to ℥j of water, or more, according to Trousseau), which is to be painted over the sore by means of a fine brush. He prefers the various sodium-salts to the potassium-salts, and gives solutions of borax and nitrate of soda in decoctions of sage. He recommends also cleanliness and ointments against the erythema on the rectum and the genitals.[1]

[1] Appendix C.

Reubold, whose therapeutical views seem to me the most rational, states—"The causal treatment of the disease belongs to the therapeutics of the intestinal tube; parasiticidal remedies alone ought to find a place in the treatment of the thrush. Cleanliness and removing the fungus are no doubt urgently required in many cases, as, for instance, when the fungus is seated on the *isthmus faucium;* but surely these are not the only means, as Bednâr thinks. (I believe that the absolute condemnation of the process of wiping off the fungus, and the inveighing against this custom so often met with in nurseries, is frequently the effect of ignorance, and shows a thorough want of knowledge of the nature of the disease.) Uninjurious parasiticidal remedies applicable to the mucous membrane of the mouth are not known. Borax is harmless (Oesterlen and Jörg); other metallic astringent salts act against the catarrh itself, when they act favorably. Alkalies which remove acidity have been abandoned for a long time; and Berg's theory of acidification loses more and more ground every day. Five grains of sulphate of copper in half an ounce of water is likewise ineffective, according to Reubold. Nitrate of silver was found most effective against diarrhœa in the Würzburg Clinic, and a little wine should the child's weakness increase."

I would urge the use of small doses of iron, as, for instance, lactate of iron, together with carbonate and phosphate of lime, or the creosote-water united with the salts of lime, which I have frequently found effective in cases of diarrhœa accompanied by fungi in infants. Solutions of an iron-salt, especially when followed by a small dose of cod-liver oil (10—20—30 gtt. per day in the case of children upwards of one year), were found most effective in removing atrophy and its consequences, and in accelerating convalescence.

History.—In order to be able to survey the history of this disease it becomes necessary to sum up all that has been said of aphthæ, muguet, and thrush, and, above all, to abandon the French mode of dividing it into separate diseases, which are in fact merely gradations of one disease. Robin did not even proceed thus. If we proceed from this point of view and master the entire literature which was collected with great pains by Berg, we may take the following historical view:

1*st period.*—*Period of Hippocrates,* who knew and described

the actual thrush of children under the name of aphthæ ('Aphor.' Sect. iii, No. 24).

2d period.—Corruption of this idea by the Roman medical writers, who wrongly translated this word by *ulcera.* This corruption has been retained from the time of Celsus to the present time, and comprises both *Stomatitis vesicularis* and *S. follicularis.* Celsus confounded the real aphthæ with all kinds of ulcerous, exudative, diphtheritic, and gangrenous disorders of the mouth and throat, with *Stomacace, Noma,* &c. Galen confounds the thrush especially with *Stomatitis follicularis* and *vesicularis* with their ulcers and others. Aphthæ were treated like ulcers by Aretäus, Oribasius, Aëtius, Paulus Ægineta, Primerose (1508); Amatus Lusitanus (1551), who describes a case of thrush on a grown-up person taken ill with intermittent fever; Fernelius (1569); Ambrosius Paré (1575), who recommends with Rüff the simultaneous treatment of nurses and infants; Mercurialis (1583); Forestus (1591); Herlicius (1597); Sennertus (1646, ulcuscula seu tubercula oris) mentions as *remedium fœtidum* the frequent sucking at a living frog, which he thought would remove the malignant secretions; Joël (1665, exigua ulcuscula seu pustulæ); Riverius (1646, the different distinctions of colour are supposed to be produced by bile, mucus, *atra bilis,* and putrefaction); Mauriceau, Riedlein (1698); Loew (1699) (*Prunella infantulorum* = thrush); Becher (1700); Slevogt (1706) speaks of two species—*Ulcuscula* and *Papulæ,* which form vesicles; Boerhave (1709), who was acquainted with the piecemeal loosening, falling off and reappearance of the sloughs, till larger ulcers were formed; Juncker (1718), observed that they might be wiped off; Dionis (1718); Astruc (1746); Cooke (1770); Nicolas (1722); Plenk (1776, ulcera cutanea); Selle (1802); Heberden (1804); Henke (1810-21); Swedians (1812, ulcers, vesicles, pustules; they belong to his Pyrexiæ, order Phlegmasiæ).

3d period.—Return to the name given by Hippocrates.—It is scarcely necessary to speak of this as a distinct period, as it only included a few isolated writers who endeavoured to return to the most ancient name, but whose voice, however, was disregarded. I may mention Pollux ('Onomastic,' l. iv, c. 24, sect. 200); Girtanner (1794), who calls them vesicles or spots on the lips; Brassard (1837).

4th period.—Period marked by the endeavours to describe

more exactly the aphthæ, and to distinguish them from other diseases at other ages; a general abandonment of the view of the ulcerous nature of aphthæ, and a prevalence of the view that they were exanthematous. (The German-Dutch school of the Middle Ages to the present time.)

Rüff (1554 and 1580), and his Swedish translator Benedict. Olai (1578), call them leaflets (Blätterlein); Hollerius (1579), vicarious eruption (beneficium naturæ), their arrest creating atrophy of children; Scipio de Mercuriis, and his translator Welsch (1653), white vesicles, with a red base; Ketelaer (1652), complication of the Dutch marsh-fever; he was the first who described well the aphthæ of adults; no ulcers but *tubercula;* empyreuma, which was to be separated by way of the newly discovered lymphatic vessels, opposed to the theory of the cause of the colour of the aphthæ; extension of the same to the whole intestinal canal; creating *an epoch.* Ettmüller (1675, tubercula) did the same for the aphthæ of children as Ketelaer did for those of grown-up people, and *created likewise an epoch;* Pechlin (1691), aphthæ-blossoms, rising from the stomach to the mouth, analogous to a process of sublimation; Cregutus (1696), like Ketelaer; Lentilius (1709), pustulæ miliaris albæ; Voeltern (1722), "Blätterlein," which render the mouth as rough as a grater; F. Hofmann, "Blätterchen," the seat of which are the glands of the mucous membrane (1741); Pelargus-Storch (1750), "Blätterchen" and ulcers, of the matter of which, whether it be acid salt or acid, we are ignorant; Börner, "Blätterchen" and vesicles (1752); Van Swieten (1754), pustulæ, which are generated by the obstruction of the natural ways of exit to the hardened mucus of the tongue and the mouth; Sauvages (1755), phlyctænes, papulæ subrotundæ, semilineares; Linné (1765), morbi exanthemat. sporadici, escharæ albidæ; Rosenstein (1764, translated by Murray, 1798), scurfs; Armstrong (1765), spots and vesicles; Cullen (1769), exanthemata, escharæ; Unzer (1770), patches, forming a scab; Sagar (1771), exanthem. contagiosum; Mellin (1781), "Blätterchen," Soor = Kurvoss, because it is a curable disease—affecting the nipples, "Fasch," in which case the breast is best protected by oil; Starke (1784), vesicles caused by the stopping up of the efferent channels of the glands—although they are not dangerous it is well not to disturb their eruption; the German translator of Cullen (1785), ulcers of the size of millet, never any primary ulcers; Underwood (1784), white layers

springing from spots; J. P. Frank (1792), exanthemata scabra,—he confounded them with stomatitis; Hufeland (1792), critical phenomenon; Fleisch (1808), vesicles, stomatitis vesicularis; Jahn (1803), local disease, dots, fissures, vesicles; Gardin (1807), critical exanthem of white tubercles, moreover identical at all ages; Capuron (1821), translated by Puchelt, a critical exanthem; A. G. Richter, pustulous exanthem; Good (1822), granulated vesicles; Wendt (1823), white spots and vesicles; Josephus Frank (1830); Eisenmann exanthem; Schoepff (1841), *idem.*

5*th period.*—The period in which *Muguet* meets with a special description, and is separated from aphthæ, by the French school.

Knellie, an Englishman, is the first who describes the *Muguet,* although he does not give it that name. The French school begins with the year 1738, when the attention of the government was called to the excessive mortality at the Paris Hospital for Children, with the work of Martinet, 1740, who calls the disease *Blanchet,* or *Muguet,* and who ascribes to it a contagious character. Colombier (1779), de petits boutons blancs et durs; Doublet (1783) describes accurately the course of their development. Amongst the competitors for the prize given at Paris, in 1786, who were successful, were Sarponts, who distinguishes "aphthæ in puncto albicantes et pustulæ miliares," and recommends inoculation as a protection; Auvity, who separated aphthæ and muguet, and mentioned the glands of the mucous membrane as their seat; Van de Vieupersse, who classifies them with the exanthemata, as being more related to miliaria, and therefore critical, and knew that the vesicles discharge no liquid; Coopmans, who says, the word *aphthæ* was used for "stomacace" and "noma" by ancient writers, whilst they are tubercles or pustules around the rectum—aphthæ are the same in the North as miliaria are in the South; Arnemann, who says, aphthæ are neither ulcers nor pustules, but white tumours, consisting of three species—the commonest are those of foundling-hospitals, and those of grown-up people, which latter alone are critical; and Lentin, who calls them a non-critical formation of papillæ. Wedekind knows them to exist in an isolated state (*Stomatitis follicularis*), and aphthæ in heaps (true aphthæ and diphtheritis); Hecker (1815), in his otherwise good description, is, however, defective,—he divides *Aphthæ neonatorum,* the same as "soor" and Schwämmchen (thrush); Bertin (1810); Geoffroy (in the 'Dictionnaire des Sciences médic.,' 1812); Dievilliers (1819, *ibidem,*

article "Muguet"), the name *muguet* is derived from the resemblance in colour and form to the flowers of "*Convallaria maialis*;" Heyfelder (1828); Guersant and Blache (*ibidem*, 2d edition, carrying out further Wedekind's views); Lelut (1827); Billard (1827), "Stomatitis follicularis" = aphthæ and stomatite avec alteration de secretion = muguet; Dugés (1829) only increases the confusion; Pieper (1831)—like Billard, he does not, however, perceive the resemblance to mould, and describes the *Stomatitis follicularis*, the latter being entirely confounded with thrush by Rau (1831); Eisenmann (*Stomatopyra Soor* and *Stomatopyra aphthæ*, which are exanthems); Gordinet (aphthæ, a disorder of the mucous glands; muguet, an exudation); Naumann (aphthæ = a formation of phlyctenæ; soor = *Stomatitis exsudativa*, or in the 2d edition, *Angina aphthosa*); Bouillaud, de la Berge, and Monneret, who caused great confusion; Schnitzer and Wolff; Bouchut calls aphthæ what is, in fact, *Stomatitis follicularis*, and applies muguet to the real fungus. All the renowned medical authorities of France and Germany, down to Cannstatt, when he wrote his first edition, share the faults spoken off, and it appears to me superfluous to enumerate them all. The exceptions will be mentioned in the last period.

6*th period.—Period of the proof that aphthæ and muguet are identical.*—Double (1803), it is no inflammation, but a disease which occurs on red spots, forming white pustules; O. L. Bang; Heyfelder thinks that aphthæ and muguet are synonymous—he confounds, however, aphthæ and *Stomatitis follicularis*. Barkhausen thinks that Peyer's and Brunner's glands were often mistaken for aphthæ. Frankel (1838), muguet, a variety of aphthæ.

Period of the knowledge of the true fungous nature of aphthæ.

Jahn first observed, in Hufeland's 'Journal,' 1826, that the people had rightly conceived a similarity to exist between this disease and mould, and compared the physical development of both. But as he did not believe the lowest moulds to consist of really organized plants, he also viewed these fungi merely as physico-chemical products. He is of opinion that a peculiar fungous mass exists, and that the fungi are sometimes produced by other species of mould, as, for instance, *Merulius destruens*.

Although J. Frank ridicules this idea, Jörg likewise speaks, as early as the year 1826, of fibres of fungi.

Langenbeck first described a fungus (in Froriep's 'Notizen,' No. 252, 1839) which occurs on the aphthous layer in the œsophagus of a person who died of typhus, and gives more details (1840), without knowing, however, whether this fungus was of constant occurrence.

Berg accidentally saw, in the winter of 1840-41, the mould which grows on old milk, and was surprised to find such a great resemblance between mould-fibres and those which he found in the aphthous discharge. He communicated his observation to Gruby, who considered the fungus to be analogous to the favus, and reported it as such to the Swedish Association (September and November, 1841); Joh. Müller published some remarks in his 'Archiv,' 1842. Berg discussed the subject further in the 'Hygiea,' 1842. Eschricht, Vogel (as resembling the favus-fungus), and Buchner described the fungus in 1841. The latter continues the comparison of fungi which Jahn began, and mentions as analogous to the noxious effects of spores of the fungi, three cases of poisoning caused by the sporidia of *Æthalium septicum*, as well as his own stupor after swallowing the spores of Boletus. Hannover's *Leptomitus* (1842) and Bennett's expectoration-fungus are, according to Berg, nothing but aphthæ. Oesterlen knows the fungus (1842), but considers it to be merely accidental. Gruby, who, with Berg, was the first to discover the vegetable nature of the aphthæ, described the fungus as *Sporotrichum* (1842), and called it *Aphthaphyte*, and assumed as its cause severe epithelial disease. Rayer and Montagne, Andral and Gavarret, were likewise acquainted with this fungus. The latter saw it also generated when albuminous substances were left standing together with vinegar. Eisenmann (1845) attributes the fungus to a "generatio æquivoca." Bouchut knew the fungus which occurs on real thrush, and calls it muguet, whilst his aphthæ are *Stomatitis follicularis*. Remak states that the fungus occurs only secondarily after the loosening and ulceration, but does not know its pathogenetical significance (1845). Hoernerkopf and Baum adhere to Berg's views. Empis, next to Berg, has the merit of enlarging our knowledge of this fungus. Gubler thinks that the fungus originates in the interior of the salivary glands; Bazin, in the follicles which generate the slime. Bednâr is well acquainted with the fungus, but confounds the name soor

(thrush) with aphthæ and stomatitis. He speaks of two forms of thrush. The first kind, which he only observed during an epidemic of measles, is said to be remarkable for its excessive luxuriance, formation, and detachment of the epithelium of the mouth (pavement-epithelium), together with mucous corpuscles and oil-globules without fungi; the second form of soor consists of real thrush. Reubold saw the first form only once during an epidemic of measles, and he describes it quite correctly as "*Stomatitis morbillosa.*" This stomatitis formed on the lips and the parts of the gums which correspond to them, more rarely on the tip of the tongue, a thin layer of white, small gritty discharge, accompanied by pain, inflammation, and swelling of these parts. The discharge fell off without causing ulceration, and exhibited corpuscles of mucus and pus, without a trace of pseudo-membranes or fungi, besides a plentiful epithelium, and they never occurred on toothless children. It was only after this disease had had its course that thrush-fungus was once observed to break out. Reubold, who recently gave a more correct description of aphthæ, and who deserves great merit, always saw the fungus at the very beginning of aphthæ. He adopted, however, the French theory, and views aphthæ and thrush as two distinct forms of disease.

Experimental Appendix.

Experiments made by Berg in order to ascertain the most favorable medium for the development of the fungus.

Berg took scabs of aphthæ, weighing two or three grammes, from a living child, and poured distilled water over them, and allowed them to stand at a temperature of 12—15° C. (53—59° Fahr.) He found after the lapse of five days numerous sporidia in the liquid, which were larger and more developed and more copious than at the time when the scabs were detached. He also observed that there was a connection between two or three of them, and that their stalks were twice as thick, whilst other fungus-formations were wanting. A similar result was obtained by the experiments for preserving the scabs in a liquid mixed with arrow-root powder at the same temperature. Luxuriant fungous formations were also seen shooting up from the scabs

that lie on the bottom in a solution of sugar. Berg thinks that they also belong to the thrush-fungus. No particular formation of aphthæ was observed in the case of scabs which were preserved in pure water at a temperature of 30—35° C. (86—95° Fahr.), but they were very numerous when the scabs were preserved in the mixture of arrow-root. A small cloud was perceived after forty-eight hours, consisting of the fungus, but possessing only few and short stalks. The process proceeded most luxuriantly at the same temperature in a solution of sugar, the result being the formation of a white mouldy membrane or layer on the surface of the liquid, which is said to have been produced by small patches of the aphthæ-fungus which floated in the liquid, whilst at the same time a gas was emitted from the liquid employed. The same phenomena were observed in a solution of cane-sugar mixed with albumen, in which fungi grew for ten days. Solutions of milk-sugar likewise exhibited a mouldy membrane, with similar sporidia to those of the aphthæ-fungus.

Berg next examined the stems and spores of isolated fresh thrush-fungi, after having carefully removed all organic portions of the epithelium, &c. He did not succeed in tracing the growth of these fungi in distilled water at a temperature of 30—35° C. (86—95° Fahr.), but he noticed a slow growth of the fungous elements in a hermetically sealed-up solution of sugar at 15° C. (59° Fahr.), and a more rapid one in solutions of sugar containing albumen, the growth being, however, slower in the latter case at a temperature of 15° C. (59° Fahr.)

Experiments on the thrush by Berg.

Berg took scabs of aphthæ, and mixed concentrated solutions of borax, soda, alum, and corrosive sublimate (about one twentieth part) with a solution of cane-sugar containing the scabs. All these compounds seemed to impede their growth. The solutions to which borax or soda had been added exhibited gradually a less alkaline reaction, and on exposing the scabs perhaps longer than for a period of six days, another result might probably be obtained. The same took place when eight grains of nitrate of silver were mixed with one ounce of water and nineteen twentieths of cane-sugar and scabs of aphthæ. I cannot see the use of these experiments, as the aphthæ-fungi exist here under different circumstances to what they do naturally. If therapeutics are to be

benefited, it can only be done by submitting the fungi, which form a mouldy layer on albuminous substances, to the remedies employed in the experiment, and by placing fungous elements for some time in the solutions of such remedies, watching whether they continue to grow when brought together with fresh albumen.

Experiments on the question whether the scabs of aphthæ have the power of converting milk-sugar into lactic acid, and thus acting as a kind of ferment, and simultaneously producing an evolution of carbonic acid and the generation of acetic acid:

1. A glass tube was filled with cane-sugar dissolved in eight parts of water. Reaction neutral; after seven days, still clear and neutral.

2. A glass tube was filled with milk-sugar. Reaction neutral; after seven days, like No. 1.

3. Ditto, with a thin mucilage of arrow-root starch. Reaction neutral; after seven days, still neutral; a deposit of starch-envelopes.

4. A tube was filled with human milk. Reaction slightly alkaline; after twelve hours it was sour, and coagulated slightly after twenty-four hours.

5. Ditto, with cow's milk. Reaction slightly acid; after ten hours, found to have almost completely coagulated.

6. Ditto, cane-sugar, with two grains of scabs of aphthæ. Reaction neutral; after twelve hours, acid reaction; after thirty-six hours, acid, and a cloud of fresh spores of aphthæ.

7. Ditto, with two grains of yeast-fungi. Reaction neutral; after one hour, fermentation and acid reaction.

8. Ditto, with two grains of acid stomach of a child. Reaction neutral; after nine hours, acid; after thirty-six hours, strongly acid, the stomach breaking up on shaking; three or four days later, the liquid opalized, and exhibited some sporidia resembling the aphthæ-fungi, some fine fibres like the tooth-alga.

9. A tube contained milk-sugar with two grains of scabs of aphthæ. Reaction neutral; after nine hours, acid; after twelve hours, slight fermentation; in four or five days, a mouldy membrane, with sporidia of the aphthæ-fungus without stalks.

10. Ditto, with two grains of yeast-fungus. Reaction neutral; evolution of gas in the course of an hour; acid without fermenta-

tion after twenty hours; in forty-five days, a yellowish-gray cover of mould, unlike the aphthæ-sporidiæ.

11. Ditto, with two grains of acid stomach of a child. Reaction neutral; after thirty-six hours, as in No. 8; in three or four days, opalization of the liquid and a mouldy scum, with sporidia and fibres resembling those of aphthæ-fungi, as in No. 8.

12. A tube with a paste of arrow-root starch and two grains of scabs of aphthæ. Reaction neutral; acid after twelve hours; after forty-eight hours, still more acid; cloud of fresh aphthæ-fungi.

13. Ditto, with two grains of yeast-fungus. Reaction neutral; after six hours, a slight evolution of gas; acid after thirty hours.

14. Ditto, with two grains of acid stomach. Reaction neutral; after twelve hours, acid; after thirty-six hours, as in No. 8; in three or four days, infusoria and fibres, as in No. 8, without sporidia of the aphthæ-fungus.

15. A tube with human milk and two grains of scabs of aphthæ. Reaction neutral; after three hours, acid; after twelve hours, coagulated; in three or four days, pretty copious generation of fresh sporules of the aphthæ-fungus.

16. Ditto, with two grains of yeast-fungus. Reaction neutral; after six hours, no change; after twelve hours, acid with fermentation, without coagulation.

17. Ditto, with two grains of stomach. Reaction neutral; after three hours, partial coagulation; after six hours, acid; after thirty-six hours, very acid; stomach dissolved; in three or four days, as in No. 14.

18. A tube was filled with cow's milk and two grains of scabs of aphthæ. Reaction slightly acid; after two hours, acid reaction; after four hours, also coagulation; after six hours, general coagulation; after twelve hours, still more distinct.

19. Ditto, with two grains of yeast-fungus. Reaction slightly acid; after two hours, acid reaction; after four hours, ditto; after fourteen hours, slight coagulation, without fermentation.

Experiments on the question as to whether the completely pure aphthæ-fungi possess the power of exercising a modifying influence, especially the promotion of acidification, on a solution of sugar:

I. A few drops of the albumen of an egg were mixed with water. Reaction neutral; temperature, 12—15° C. (53—59°

Fahr.); after a short time, flakes of albumen; no fermentation up to the eighteenth day; still neutral after six days.

II. Ditto, with addition of cane-sugar, at 30—35° C. (86—95° Fahr.); quite as in I; acid in forty-eight hours, no fermentation.

III. A solution of sugar with clean aphthæ-fungi; neutral at 12—15° C. (53—59° Fahr.); after thirty-six hours, acid; no fermentation; no addition of aphthæ-fungi.

IV and V.—Ditto, but at 30—35° C. (86—95° Fahr.); during the first few hours, slight evolution of gas around the parts of the fungi; in twenty hours, distinctly acid; no fermentation; no addition of aphthæ-fungi.

VI. A minimum of clean aphthæ-fungi with water and albumen. Neutral; at 16° C. (60° Fahr.); in sixty-five hours, acid; no fermentation.

VII. Ditto, with addition of cane-sugar. Neutral at 30—35° C. (86—95° Fahr.)

VIII—XII. Ditto, only with variation of the quantities of albumen. After some minutes, a fine flocculent deposit (albumen) round the parts of the fungi, which was soluble in potassa; a slight evolution of gas for several hours; gradually a heavier precipitate rising to the surface; on the tenth day, slight fermentation; after from eight to twelve hours, distinctly acid; increase of fungous sporidia as long as gas continued to be evolved.

Experiments by Berg on the power of the aphthæ-fungus to form acids, and on its increased growth by forming acids in presence of a nitrogenous body.

Two grains of the scabs of aphthæ were put into a solution of sugar at a temperature of 30—35° C. (86—95° Fahr.) After twelve hours, evolution of gas, acid reaction; after thirty-six hours, small fungous flakes; after sixty hours, a mouldy membrane on the surface. The whole mass was then shaken and left to itself; the precipitate was washed until it no longer gave an acid reaction. The deposit was again mixed with albumen and solution of cane-sugar at 30—35° C. (86—95° Fahr.); after twelve hours a slight, and after twenty hours strongly acid reaction was observed, and evolution of gas, which caused the spores to rise to the surface; after forty-eight hours many fresh aphthæ-fungi appeared. The whole mass was shaken up after four days. One half was put into a glass tube, and potassa added until it

was strongly alkaline. This reaction lasted for three days, the liquid remained clear and without gas. On the fourth day, the liquid was slightly acid, which went on increasing as well as the evolution of gas; on the sixth and seventh days, fresh sporidia appeared. To the other half more sugar was added, gas was evolved, and the fungi continued to increase; on the fourth day, however, the whole action ceased. The gas which was evolved was found to be carbonic acid gas by passing it through lime-water. The acid which formed after the evolution of carbonic acid gas had ceased appeared to be acetic and lactic acids.[1]

I may, in conclusion, mention the questions which Reubold puts at the end of his article, and which are to be decided experimentally.

1. Does the fungus pertain only to man?

2. Is it a separate distinct species or only modified by its local seat?

3. Are mucous membranes the only favorable soil?

4. What are the conditions of its growth and the results of the decomposition which accompanies it? Is it an acid?

5. Do different kinds of fungi occur in thrush, or are the various distinctions caused by external influences?

6. Can other fungi produce a similar disease of the mucous membrane?

7. Does a particular kind of gas (marsh-gas) favour its development? or a particular season of the year? (Reubold thinks that the fungus is of more frequent occurrence in summer, as is also the case with summer-diarrhœa.)

8. Are warm, wet summers in favour of the fungus?

Literature.—The principal work is that of Berg of Stockholm, 'Ueber die Schwämmchen von Kindern,' translated by van dem Busch, 1848; Berg, in Müller's 'Archiv,' 1842, p. 291; 'Hygea,' 1842, 12 Hft.; Gruby, 'Compt. rend.,' 1842, xiv, p. 634, and 1844, xviii, p. 585; 'Clinique des hôpitaux des enfans,' 1842; 'Annal. d'Anatomie et de physiol. pathol.,' 1846, p. 286; Vogel, 'Allg. Zeitung für Chirurgie, innere Heilkunde, &c.,' 1842; 'Gaz. méd. de Paris,' 1842, p. 234; 'Allg. pathol. Anatomie und ihre Uebersetzung durch Jourdan;' 'Icon. path. hist.' 1843, tab. xxi, 1—3; Eschricht, Froriep's 'Notizen,' 1841, No. 134; Hannover, Müller's 'Archiv,' 1842, p. 290; Hoernerkopf, 'Dissert. de aph-

[1] Appendix C.

tharum veget. natur.,' 1847, pp. 28, 29, and Baum, ibidem, p. 38; Sluyter, 'De veget. org. animal.,' Berlin, 1847, p. 18; Raynal, 'De contag. anim.,' Berolini, 1842, pp. 9—24; Weigel, 'De aphtharum natura ac diagnosi,' Marburg, 1842; Oesterlen, in Roser and Wunderlich's 'Med. Vierteljahrsschrift,' 1842, p. 470; Gubler, Note sur le Muguet, 'Gaz. méd. de Paris,' 1852, p. 412, and 'Comptes rendus' and 'Mémoir de la Société de Biologie,' 1852; Bazin, 'Récherches sur la nature et le traitement des teignes,' Paris, 1853, p. 12, pl. iii, fig. 2; Empis, Etude de la dipthérite, 'Arch. génér. de méd.,' 1850, xxii, pp. 281—289; Bednâr, 'Kinderkrankheiten,' Wien, 1850; Reubold, in Virchow's 'Archiv,' 1854, vii, 1, p. 76. The last is deserving especial notice.

Parasites resembling the thrush-fungus.

Similar parasites as in thrush are sometimes seen in the œsophagus and in vomited matters. Wedl describes the following case by Herzfelder. (Tab. V, fig. 1 *a*—*g*.)

Round spores of 0·005—9 mm. in diameter were discovered in the vomited mass, with a partly voluminous, bright, eccentric nucleus and group-like accumulations. The thallus-threads had a transverse diameter of 0·003—014 mm. The cells of the thicker threads exhibited a very large, bright nucleus, and became smaller towards the two points of meeting. Two round nuclei were frequently seen on the outermost cells. These cells were sometimes of an elongated shape, with a nucleolus towards the uniting parts. Even the thinnest threads still exhibited little granules. In the original cells of the thallus-threads were seen several granules (nuclei ?) in a separate state or in little heaps. They were most copious on the lower part of the œsophagus near the cardia of the stomach.

The mother-soil consisted of a molecular mass, together with decayed granules (remains of epithelial cells) and slightly granulated globules in striped mucous masses.

APPENDIX.

Berg found a fungus in the mouth and on small intestinal ulcers which he does not further describe.

Bennett found a fungus between the teeth and the gums of a person attacked by typhus. It was 0·003—6‴ broad; its free extremities not very numerous, and fringed by a row of spores. Little

globules were seen in the cavities of the filaments, of 0·001—2‴ in size, and longish spores in others. Bennett has since found other indistinct vegetable formations, in a yellowish-green stool, consisting of confervoid, entangled, elongated, articulated tubes, with spores, and exhibiting a great inclination to break across. (Bennett, On the presence of Confervæ, &c., 'Monthly Journal of Medical Sciences,' 1846, and 'Lectures on Clinical Medicine,' Edinburgh, 1851, p. 215, figs. 83, 84.)

Langenbeck describes similar formations in the pharynx down to the cardia, in a case of typhus.

Robin is of opinion that the latter fungus is *Oidium albicans.* ('Repertorium für Anatomie und Physiologie,' von Valentin, 1840, v, p. 45.

Remak (1845) found several kinds of fungi on aphthæ. He thinks that the generation of fungi is always preceded by softening and loosening of the mucous membrane. He also believes that he has discovered ramified thallus-threads on the pseudomembrane of a croupous patient. (Remak, 'Diagnost. und pathogen. Untersuchungen.')

It is to be regretted that these latter observations have all been recorded too incorrectly to enable us to classify them.

Reference has already been made to Wedl, Henle, Virchow, Meissner, &c., as speaking of filamentous fungi which occur in the mouth. I need not repeat what has already been said when speaking of the Algæ, according to Robin, and of *Leptothrix buccalis.*

IX. *Fungus of the Lungs* (Bennett) = Champignon du poumon. Tab. V, fig. 2.

The mycelium of this fungus is composed of long tubes, provided with partition walls and unequal articulated intervals, bearing several branches, which sometimes consist of one cell, set into the stem at the end of the last cell, and parted in the shape of a fork; sometimes simply separated into two or three elongations at their point of articulation. These branches are 0·005—0·010‴ in diameter. The spores are numerous, and are 0·010—0·014‴ in diameter. Bennett saw these spores become longer and form tubes. He found the fungus in the expectoration, in the caverns, and in their tuberculous matter, in a case of pneumothorax.

Rayer likewise cites byssoidal formations on the pleura in a tuberculous case, and in the intestines in a case of pneumothorax, without, however, describing them any further. ('Journal l'Institut,' 1842, No. 492.)

Remak speaks likewise of dichotomous, divided mycelium-fibres in the expectoration of tuberculous patients, and, more generally, in diseases of the windpipe where the epithelium of the pharynx is frequently renewed.

Gairdner describes likewise, though extremely superficially, a fungus which had its seat on the pleura, in a case of pneumothorax. (Confervæ on the Pleura, 'Monthly Journ. of Med. Sc.,' 1853, p. 472.)

X. *Aspergilli species.*

Tribe.—*Aspergillei: Recept. floccosum, simplex vel ramosum. Sporidia vesiculæ sphæricæ vel ovato-terminali inhærentia.*

Genus—*Aspergillus: Flocci tubulosi, septati, biformes; fertiles erecti, apice clavato incrassati. Sporidia simplicia, globosa, seriatim conglutinata, in capitulum rotundatum circa apices clavatos arcte congesta.*

Aspergilli (?) *species. Fungus Meatus Auditorii externi* (Mayer). Tab. V, fig. 3.

The stem is long, transparent, showing in its interior little globules, and terminating with a small, swollen, round, and greenish little head, which sits like the cap of the fungus on a small inflation of the stalk (Robin, Atlas, iii, 1). It is covered with a layer of simple or double nuclei or spores on its free edge. Between the stalks are other filaments, which are deprived of mycelium, and spread here and there, isolated or in bundles. Amongst them are found filaments in all stages of development.

It was observed in a case of scrofulous otorrhœa, in a girl eight years old, consisting of round oval cysts, of the size of a cherry, the walls of which were fibrous, white on the outer part, hollow in the interior, greenish, and granulous. These granulations were found to be organized productions, by a magnifying power of 300 diameters. Vogel thinks that it is closely related to the

fungus of the root of the hair; Robin classified it with *Mucedo* in his first edition; it belongs, however, to *Aspergillus*, the species of which are known to thrive on masses of fatty matter in a state of decomposition.[1]

Literature.—Beobachtungen von Cysten mit Fadenpilzen aus dem äussern Gehörgange, Müller's 'Archiv,' 1844, p. 401, tab. x, figs. 1—4.

XI. *Aspergilli species.*

Affinis Aspergilli capitati capitulo aureo, seminibus rotundis. Muffa dorata, gambata (*cum Aspergillo capitato, capitulo glauco seminibus rotundis,* Micheli).

Here we find—

1. *Filaments or tubes of the mycelium.*—It is composed of several very rigid, transparent, and branched tubes, separated by partition walls, and consisting of several elongated cells, with a few very small granulations, which are not, however, spores, as Pacini thought. The single cells were 0·009—0·200 mm. long, the diameter of the tubes was 0·010, the thickness of their walls 0·001 mm. They were not very numerous in the ear, but could not be preserved by Pacini underneath glass plates, and mixed with gum and arsenic.

2. *Receptacular filaments,* of pretty nearly the same diameter, 0·009—0·013, with a capitulum of 0·060—0·142 mm.; they varied in length according to the degree of development, being about 0·770 mm. Their form was very regular, of a rose colour, transparent, and possessing a strong power of resistance. They exhibited a clear cavity without granules, with two lines on each side. The stalk was thin at the base, with two or three small angular projections. Pacini mistook them for little roots. The stalk becomes then of a somewhat more uniform and larger diameter, and narrows once more shortly before the receptaculum, forming a kind of sheath analogous to the calyx of flowers. It bears a spherical inflation on its further end, the receptaculum = *placenta* (Micheli), which is thicker in young persons than in old. Its contents are a little granulated, according to Pacini; it lies in the centre of the capitulum, which is perfectly spherical, 0·060—0·100 mm. in diameter. The colour varied with the age and diameter, that of younger individuals being dark yellowish-red, and from

[1] Appendix C.

bluish to intensely black with older persons. The structure of the capitulum was distinctly discernible only in young persons.

3. *Spores.*—They were spherical, 0·003 mm. broad, showing in their free state a feeble movement (Brown's molecular motion), and forming radiated rows with the receptaculum for their centre. Each row contained from eight to fifteen spores. Some rows were occasionally found isolated, but only on ripe forms (Micheli). Each receptaculum bore, according to Pacini, 19,000 spores.

Dr. Bargellini discovered this fungus on Nardi, who had been ill fourteen years. Nardi had resorted to sea-bathing, and he stated that the water had often remained in his ears, causing him at first pain, together with itching; lastly, however, almost complete deafness. Bargellini found, in the outer auditory duct, small transparent vesicles, like millet-seed, with rather thick walls, and having a serous secretion, which prevented him from looking deeper into the auditory duct. A fortnight afterwards the latter was found to be blocked up with a whitish membrane, which could be removed by means of lukewarm water, but only made place for fresh layers. After another fortnight a blackish substance made its appearance, plugging up the auditory duct, and adhering to a whitish membrane when the syringe was applied. This happened repeatedly after cleaning the ear, and Pacini, who examined this substance under the microscope, found the above-mentioned rows of spores amidst the fat and epithelial cells, partly dyed with blood, and viewed them as algæ-spores. Injections of acetate of lead (15 centigrammes to 30 grammes of water) easily removed this merely accessory parasite, which perhaps owed its chief prosperity to the oil used for injection having become rancid. Pacini's theory of the origin of this fungus has not been confirmed by more recent researches, as observed by Robin.

Literature.—Pacini, 'Supra una muffa parasita (Mucedo) nel condotto auditivo externo,' Firenze, 1851, p. 7.

XII. *Meissner's and Virchow's Nail Fungus Aspergilli* (?) *species.* Tab. V, fig. 4.

1. Meissner found at Baum's Clinic a copious plexus of variously entwined filamental fungi on the nails of an octogenarian, which were thick and broad, with thick edges, strongly convex, re-

sembling claws, striped with a yellowish-white, or brownish colour, opaque, and which moved in their sockets, having a soft and brittle but not lacerated appearance, and being fissile like wood. These fungi became perceptible on displaying the ordinary cells of the nail by means of caustic soda, in which they spread freely, often extending beyond the edges of the section. Their mycelium consisted of long, ramified, articulated filaments, with joints of $\frac{1}{1000}$—$\frac{1}{700}'''$ in breadth, and twice to four times as long; being usually arranged in consecutive layers, and refracting the light of a greenish colour. There were, moreover, sporangia, with broad, short threads or tubes, which were not ramified, indistinctly articulated and enlarged, composed of short roundish or square divisions, which contained the spores in the shape of a rosary, with edges of double "contours," and which contained an immense number of free spores in the filamental spaces, being $\frac{1}{1000}$—$\frac{1}{750}'''$ in extent, roundish, and greenish in colour. The largest among them exhibited double contours, and a spot (nucleus?) in the interior.

The whole nail-substance of all the fingers, with the exception of the healthy fore-finger of the right hand, was permeated by this fungus, which extended in parallel rays and stripes from the root towards the surface, pushing aside the cells of the nail, and discolouring the latter. The fungus did not, however, occur on other parts of the body. The man stated as the cause of his disfigured nails, that the latter had been crushed some thirty years ago by a heavy load, that they had fallen off, but grown again, and become very thick, but he did not know whether the fore-finger also had been injured. Meissner thinks that the fungus was the cause of the abnormal growth of the man's nails. The fungus is very much like that of *Porrigo lupinosa*, and is distinguished from the fungus of *Pityriasis versicolor* (*Microsporon furfur*) by its articulated mycelium, by larger filaments, and spores.

2. Virchow mentions (l. c.) three more cases of the formation of fungi on the nails of the toes, under the head "Onychomycosis." Virchow adopts Meissner's description only generally, and does not know whether all the forms observed by the latter belong to one and the same fungus. Virchow found—

a. A very dense, copious mycelium occurring between the fissures of the texture of the nail and within the circumference of the large masses, which consisted of very fine, entirely colour-

less filaments, composed of longish joints, with double contours, frequently exhibiting very fine clear drops at certain distances, together with numerous ramifications, anastomoses, shoots of the root, and sometimes roundish projections.

b. Very fine, small, simply bordered, numerous spore-grains, with clear contents. Their development was indistinct, on account of the adhering air-vesicles; large quantities of fine spores were frequently observed lying in heaps at the end of a filament, as on a receptaculum, very much like forms of *Aspergillus.* Virchow also found germinating spores, that is, spores with fine cylindrical processes near to the larger filaments.

c. Coarser, broader, dark yellowish-brown, articulated, and ramified filaments, with oval terminal enlargements, but only once in a few examples.

d. Uncoloured, shortly articulated filaments, with larger spores arranged in rows at their extremities, frequently of a round shape and pretty large size, or with oval and smaller spores, which often extend in one direction, being connected with the next spore by means of a short flatly-ending neck, where they retained their arrangement in rows. They appear almost homogeneous in water or alkalies; iodine imparts to their interior a stronger brownish-yellow colour, lighter on the edges; and on addition of sulphuric acid they exhibit a distinct, dense, colourless, occasionally transient greenish or brownish membrane, with brown, granular contents. On treating it with more acid, the outer sac always opened on the spot where the neck was (micropyle?), allowing the brown contents to flow out. In alcohol they exhibited likewise very distinctly the bottle-shaped neck, which was only adhering to the outer envelope of the spores, whilst their interior showed a contracted granule. Virchow further states that he once found the fungus in the gryphotic toe-nails of a woman who died of purulent empyema; on another occasion in the very thick and short nails of a tuberculous individual; and on a third occasion on an old woman, in a case of nail-splitting, when he observed a yellowish-gray, powdery mass, which could be sent flying about in the air by bending back the nail, and allowing it afterwards to return to its former position. The fissures of the nail harboured in all these various cases either spores or mycelium, the part underneath the nails was always very thick, and consisted of loose horny scales, between which the yellow fungous mass, resembling in

colour the favus- or tinea-mass, was interpolated. The fungous mass, which sometimes appeared of a reddish-gray hue, invariably occurred far back, between the foliated masses, near the edge of the lunula, in large lenticular heaps. Virchow believes that the fungus is equally important to the disease of the nails just described as to *Porrigo* and *Pityriasis versicolor;* but not so to the *Gryphosis* of the nails by itself, for many more intense diseases are frequently unaccompanied by fungi.

I am only following Virchow in classifying this fungus in the mean time with *Aspergillus,* reserving for myself, however, in case I should be able to collect further information, the right to give it another place. Meissner's illustration of it would most likely classify it with *Achorion Schoenleinii;* and Virchow likewise points out that it forms a mass resembling very much the favus-mass. But *Achorion* is without articulation, which Meissner and Virchow state they have distinctly seen. Next to *Achorion* Meissner's illustration resembles the *Oidium albicans.* The entanglement of the filaments forms a kind of network, and their articulation is likewise in favour of this theory, the only objection being its different seat. According to what has been said at the end of the division, "*On the circumstances favorable for the development of the fungus,*" when speaking of *Oidium albicans,* it might be thought possible that it should also occur in the deeper layers of the nail-bed, *i. e.,* on the numberless young nail-cells analogous to the epithelium. I, for my part, am not disinclined to think that this nail-fungus is related to *Achorion* or *Oidium,* and to leave the proof of this doubtful point to some one more experienced. The nail-fungus found a place here because I should not like to contradict recognised authorities, resting on a mere "*opinor,*" and I may be permitted to quote what Gudden has said of *Achorion:* "Similar favorable conditions as the little hair-funnel offers to the reception of fungous particles would be offered by the furrow leading to the bed of the nail, if the frequent washing of the hands did not counteract it." Also the quotation of Gudden, from Canstatt's 'Hand-book of Med. Clinics,' 2d edit., p. 1092: "The horny mass of the nails suffers likewise when the extremities are attacked by *porrigo.* The nails become disfigured, they crack, and fall off."

Literature.—Meissner, in Vierordt's 'Archiv,' 1853, xii, p. 193, with tab. i; Virchow, in 'Verhandlungen der physikal med. Gesellschaft zu Würzburg,' v, 1, 1854, p. 102.

Division II. *Trichosporei* (Léveillé).

There are no species of fungi found on man belonging to this division.

Division III. *Cryptosporei* (Léveillé).

Receptacula floccosa, septata, simplicia aut ramosa. Sporidia continua, in sporangio terminali, membranaceo, columella centrali munita vel non inclusa.

Tribe—*Columellati: Sporangium vesiculosum, subtus irregulariter aut in orbem dehiscens.*

XIII. *Mucor mucedo.* Tab. V, fig. 5.

Genus—*Mucor* (Micheli): *Flocci tubulosi, subseptati, fertiles, erecti, apice æquales, terminati peridio (sporangio) membranaceo, dehiscente (raro diffluente), includente sporidia discreta.*

Species—*Mucor mucedo,* L. (= *Mucedo; Mucor vulgaris, Mucor sphærocephalus, Mucor tenuis*): *Byssinus floccis fertilibus simplicibus, peridiolis (sporangiis) sporidiisque globosis, demum nigrescentibus.*

Baum, Litzmann, and Eichstädt found this parasite in a cavity, in a case of inflammation of the lungs. It formed a black mass of filaments, interspersed with round globules, adhering to the walls of the cavern. Each filament had a process on the outer surface of the mass, terminating in an enlargement, surrounded by a row of oval cells. Sluyter views these formations as *Mucor mucedo,* adhering to Schoener's theory. The very imperfect illustrations would rather show it to be an *Aspergillus,* as Robin observed.

Robin leaves undecided whether the parasites found by Degner and Horn, in a case of *gangræna senilis,* and which the latter believes he has discovered likewise on certain purulent spots and blistered surfaces exposed to the air, belong to this division or not.

On looking at the illustrations, I am unable to find sufficient distinction from the species of *Aspergillus* described under X.

Literature.—Sluyter, 'Dissertatio,' pp. 14—29, fig. 1.

XIV. *Puccinia Favi.* Tab. V, fig. 6.

Division IV. *Clinosporei* (Léveillé).

Receptac. variabili formâ, clinodio obtectum aut clinodium in receptaculo inclusum.

Tribe—*Coniopsidei: Receptac. carnos., coriaceum, tremelloideum pulvinat., gibbum aut linguiforme; primitus celatum, dein exoriens. Sporid. decidua, simplicia vel septata, sessilia aut pediculata.*

Section—*Phragmidiei: Receptac. carnos., coriac. vel tremell. Sporid. pedicellata et septata.*

Genus—*Puccinia: Sporidia uni-, rarius biseptata, appendiculo filiformi pedicellata et matrici adnata, in tuberculum concrescentia.*

XI. Species 74—*Puccinia Favi* (Ardsten).

The colour is constantly of a very distinct brownish-red, whether viewed by day or candlelight, which latter usually causes slightly coloured objects to appear colourless. It is of an elongated form, at one extremity more or less longish, and occasionally, but not very frequently, a little angular (*i. e.*, its body); the other contracting into a stalk. Both exhibit sometimes a slight contraction at the joints. The body always divides into two cells, by contraction of which the one nearest the stalk is the thinner. The broadest part of these cells is the one nearest to the point of contraction, whence both decrease in breadth. They vary to some extent in shape. The upper cell, situated towards the body, is roundish and elongated, having its greatest diameter either running parallel to the axis of the plant or perpendicular to it; the lower, being situated nearer the stalk, is longer and more angular, sometimes forming a regular triangle with rounded angles. A cell-wall (= tissu cellulaire) and contents (nucleus, Ardsten) are to be distinguished in both cells. The contents appear sometimes homogeneous, sometimes granular, sometimes spongy, full of holes or pores, which is probably caused by different illumination. The cell-wall is quite homogeneous and clear—brighter or darker than the contents, according to the amount of light. Both cells are surrounded by a very smooth membrane, which is best seen where an empty space occurs between the cell-wall and the surrounding membrane, viz., at the upper extremity of the plant; sometimes also at the place of con-

traction, when the latter does not run exactly in a vertical direction. The stalk varies most in size (from 0·00015—0·00030 mm.) and in diameter (from 0·00032—0·00160 mm.); it always appears quite flat, sometimes round at the end, sometimes broad and blunt; and, in that case, generally very short, often twisted, or ending towards its lower end in two hooks. It is sometimes found without a stalk, which was probably torn off. Robin observed four abnormal articulations in *Puccinia*. The latter is always very soft, especially its stalk, which rolls itself up from one side to another when it is long.

This parasite is more likely to be met with in the small fine white scales at the commencing formation of the crust below, than on the large yellow favus-scales. This is, however, not always the case. The place which the *Puccinia* occupies is not always easily determined, and it is doubtful whether it thrives best on the outer or inner surface of the scale, or—what appears to be most probable—in its midst. The whole plant is 0·00200—348 mm. long, the body alone 0·00415—188 mm., and the stalk 0·00032—0·00160 mm., whilst the body alone is 0·00056—70 mm. broad, and the stalk 0·00015—30 mm., the cellular tissue being 0·00008—10 thick. It cannot be denied that this parasite belongs to Corda's *Puccinia,* according to the above description. Among the fifty species separated by almost imperceptible distinctions, it stands nearest to *Puccinia Alliorum, P. Virga-aurea, P. Polygonorum,* especially to the last mentioned, differing from it only in a few points, on account of which Ardsten places our fungus in a separate species, which he calls *Puccinia Favi,* because it is principally met with on crusts of favi, although not exclusively, since it also occurs in other diseases of the skin, for example on the fine scales in pityriasis. The *Puccinia,* which was first pointed out to Ardsten by Boeck, of Christiania, occurs very frequently, if not always, in cases of favi. It is often very difficult to discover, and a single scale may often be examined for hours and no *Puccinia* discovered. Cazenave, who has not yet been brought to acknowledge the vegetable nature of the favus, regards *Puccinia* as merely an abnormal product of secretion. Robin thoroughly refuted Cazenave's view, and we cannot do better than quote his final sentences:

1. *Achorion Schoenleinii* deteriorates the skin, and causes disease by its incessant accumulation and increase.

2. *Puccinia* is merely an accessory epiphenomenon, often

wanting, and when it occurs is found on Achorion, or more frequently on epidermal scales.

Literature.—Ardsten, in 'Gazette des hôpitaux,' Paris, 1851, October 14th, pp. 477, 478; and 'Annales des maladies de la peau et de syphilis,' Paris, Août, 1851, 2d series, vol. iii, p. 281.

Pseudo-Parasites

Belonging to the class of Algæ and Fungi.

1. The cholera-fungi or algæ of Swayne, Britten, and Budd are best known among the pseudo-parasites, being, to a great extent, remains of food or medicines, and occurring also in many other diseases. One portion of these bodies is in reality nothing more than the alga of fermentation (*Torula* = *Cryptococcus cerevisiæ*) and is likewise found in the urine of cholera patients. Another part consists of carbonates or chalky concretions with cellular tissues. Many resemble even certain eggs of the *Helminthi*, which is easily perceived on comparing the illustrated representations of this cholera-fungus which have appeared in the 'Illustrated Leipsic News.'

2. *Bodies analogous to bezoar-stones, which have passed off from the bowels or during vomiting, have likewise been believed to be vegetable parasites.*

Denis describes such a body thrown up by vomiting, which Braconnot recognised to be ligneous (ligneux), in the case of a man thirty-six years old, and another in the stool of a man eighty years old. Laugier thinks that a part of them which exhibit distinct woody fibres may be traced to the remains of chewed wood, especially to liquorice. They are the so-called *Egagropiles* of authors, found on men and animals, on horses, and are traceable to the husks of oats, as they are also found in men feeding on oatmeal.[1] I would add, that they are probably also produced where bread baked of coarsely ground flour forms an article of consumption. Others may perhaps be traced to undigested shells (of almonds, plums, fruit, and potatoes, or of coriaceous fungi). There is no characteristic sign whatever of a cryptogam discernible. The case of obstruction of the *ductus Bartholin.*, mentioned by Strahl, in Vierordt's 'Archiv,' 1847, pp. 481, 482, seems to be of the same kind. A mass of

[1] Appendix C.

elongated, slightly entangled filaments, which exhibited a wall, a channel, and contents, not being acted upon by vinegar, hydrochloric acid, and caustic potash, the latter of which destroyed the link existing between them, stopped up the channel, and caused great pain, which ceased with its removal. Strahl thinks that he probably tore off the roots of the plant which were seated in the *ductus*; in which case, however, the fungus ought to have grown again. Strahl afterwards thought that they were merely the remains of vegetable food; or, what I think more likely, cotton-threads, which the person used against toothache, imbued with various remedies.

3. Robin mentions that Von Siebold at one time viewed the dust of the blossoms of Orchidaceæ, which had fallen on certain Hymenopteræ and Lepidopteræ, as cryptogamic parasites, which was, however, contradicted by Schlechtendahl, and Von Siebold retracted his view at a later period. I would warn all observers against similar misconceptions of the fungi on man, and may be allowed to relate the following case. A robust child, of one and a half year, had a moist skin disease on the left upper-arm I examined for spores of vegetable parasites, but was unable to find any; but I frequently discovered in the crust which had been lifted off a body resembling a receptaculum filled with spores, and which was not changed by treating it with caustic potash. After searching for several days, I discovered at last that the mother of the child had used the seeds of club-moss (Lycopodiaceæ) as dusting-powder, without my knowing it, and I recognised at once these bodies as the spore of a Lycopodium. It is, therefore, necessary that medical practitioners should pay particular care and attention to the dusting-powders, such as starch-powder, &c., used by the people, or they may run the chance of discovering new parasites where there are none. Other seeds and spores of similar minuteness, or the pollen of flowers, are likely to be mistaken for parasites, when persons who move about in forests and in the open fields come in contact with the blossoming or fructifying plants, and when they are attacked by moist eruptions, forming scales or scabs on the parts of the body which are left uncovered.

Vegetable Parasite from the Vagina.

A case of diphtheritic inflammation of the intestine was observed at the Lying-in Hospital at Dresden by Professor Dr. Grenser.

A similar process occurred afterwards in the vagina, forming a membranous layer on the mucous membrane of the vagina, which was thrown off in single pieces. A slight improvement was noticed. Prosector Dr. F. A. Zenker recognised in these masses scanty pavement-epithelium, and entangled fungous filaments and spores, which were entirely surrounded by mucus-corpuscles. Dr. Zenker was kind enough to send me some of these broken pieces, and I obtained on addition of strong vinegar the partly articulated filaments of which I have given an illustration on Tab. V, in fig. 8. In order better to recognise the shape and articulations of the very diaphanous filaments, I added *Syrupus Rubi Idæi*, which fully answered its purpose, and which I would recommend for the purpose of examining vegetable parasites by means of acetic acid. I use, however, a red ink when I employ potassa, since the *Syrupus Rubi Idæi* would change its colour in alkalies.

The above parasites remind us of those which Hannover found on the ulcerated mucous membrane of the œsophagus, and in cases of typhus. They very much resemble *Leptomitus Hannoveri* (Tab. I, fig. 8), and ought accordingly to be classified with the algæ of Robin.

This parasite resembles slightly the fungus given in Tab. V, fig. 2, which Bennett found in the lungs. It appears to me, however, that we have in fact to deal with a *Leptomitus*.

Experiments

Made in order to test the parasiticidal effect of the most urgently recommended remedies.

I could not succeed in generating a continuous growth of mucedinous fungi in mixtures of albumen and blood and water, even after adding sugar, nor on *Ascarides lumbricoides* which had been left to putrefy, and I resorted therefore to the mould of very black bread, which I succeeded in keeping in a good thriving state for weeks.

Chance pointed out to me a pretty large piece of the so-called pumper-nickel-bread, which I had bought warm at Cologne, and which had been very much squeezed on the journey, so as to render it highly humid and sticky, promising, *à priori*, on account of the slight porosity of its interior, to keep for some time in that moist state, and which is so favorable to the growth of fungi. After this bread had become covered with dense mouldy

masses all over, I divided it into several square pieces, of the size of an inch, and wrapped them up in paper, putting them back to the same place where they had been getting mouldy, some after having been previously treated with the above reagents.

The following experiments were made :

June 8th, 1855.

1. A piece of bread, luxuriantly covered with mould and heaps of spores, was brushed over with *Tinct. Veratri albi* on one side, whilst the other was left untouched. As soon as the tincture touched the mouldy threads they shrivelled up, whilst the heaps of spores soaked up the tincture with great avidity, so as to make the wetted spot look as if it had been treated with oil.

2. Another piece of equal size was wetted with a solution of *Cuprum aceticum* (1 part to 100 parts of water). The mouldy filaments, as well as the heaps of spores, allowed the solution to run off, and retained only a few drops similar to the drops on the plumage of water-fowls after bathing. The water carried, however, mechanically away a greater or lesser quantity of spores, or else the latter were brushed off by the drops of the solution, and sent flying about in small clouds of dust, and not the least absorption or retention of the solution on the fungus was discernible.

3. A similar piece was treated with a solution of corrosive sublimate (1 part to 500 parts of water). The same phenomena presented themselves as in No. 2.

4. Another piece was brushed over with *Aqua phagad. pharmacop. Würtemberg.*

5. Ditto, with a concentrated watery solution of tannin.

6. Ditto, with a concentrated watery solution of borax.

7. Ditto, with *Aqua Creosoti ;* and

8. Ditto, with *Aqua Picis,* with precisely the same result as in No. 2.

9. A similar piece was brushed over on two sides with *Unguentum Picis.* The filaments of mould shrivelled up at once, and the heaps of spores could be smeared with the ointment without causing clouds of dust to rise.

10. Other pieces were preserved.

June 9th.

1. The filaments of mould were found to be shrivelled up on

the places brushed over with *Tinct. Veratri,* the heaps of spores likewise, and no trace of dust from the spores was perceptible on shaking these parts. Fresh mould had been generated on the adjoining side which had been left unbrushed. The latter was then likewise brushed over, as well as the former, with *Tinct. Veratri.*

2. Numerous fresh mouldy fungi were discovered on the parts which had been brushed over with *Cuprum aceticum:* the spores raised a dust as before on brushing them over afresh. Quite the same phenomena were observed.

3. On the piece treated with *Mercurius corrosivus,*
4. „ *Aqua phagad.,*
5. „ Solution of tannin,
6. „ Solution of borax,
7. „ *Aqua Creosoti,*
8. „ *Aqua Picis.*

Nowhere did a decrease of fungi become perceptible; the spores raised a dust, the mould-filaments stood upright, and continued to fructify just like the unbrushed pieces of No. 10.

9. On the piece treated with *Unguentum Picis,* every formation of fungi and fungous spores had ceased, whilst the already existing fungi continued to grow. Nos. 3 to 9 were freshly brushed over on that day on the old and new parts.

June 12th.

1. Nowhere any fresh formation of fungi. The spores formed a shapeless, sticky mass. No further treatment in this case.

2—8. The several pieces exhibited as luxuriant a formation of fungi as the unbrushed pieces in No. 10. The same changes were, moreover, observed as were mentioned to have been noticed on the 9th of June.

Accordingly a fresh process of brushing over was resorted to on the 12th. A regular bathing of the pieces of bread in question in the remedies mentioned under Nos. 2 to 8 took place, so as to saturate with the solutions even the pieces of paper in which the bread was wrapped up.

No. 9 showed no trace of fungi on all the parts which had been rubbed over with the solution. The ointment was therefore once more applied to fresh parts, and, by preference, on fissures and furrows.

A part of No. 10 bread was also taken and treated, as No. 11,

with a liquid of 1 part alcohol and 3 parts of water. Even this liquid was found to adhere pretty much without running over the fungous masses. A mixture of equal parts of alcohol and water, marked as No. 12, adhered to the spores of the fungi even better.

June 15th.

No. 1. None of the fungi exhibited the least trace of growth on the brushed parts, but were found to be entirely dried up.

Nos. 2—8, as well as No. 10, exhibited a luxuriant growth of fungi.

No. 9. No trace of fungi on the parts brushed over.

Nos. 11 and 12 exhibited a slight formation of fungi only on the corners left untouched by the ointment, and none at all on the parts which had been rubbed over.

The following alterations were then made:

No. 1 was once more steeped in *Tr. Veratri.*

Nos. 3 and 5 were treated with a solution of equal parts of the hitherto employed mixtures and alcohol of 80° (?).

Nos. 11 and 12 were once more brushed over with alcohol, as on the 12th of June; and a fresh piece was brushed over, as No. 13, on three different sides, with *Tinct. Veratri,* alcohol at 80°, and diluted alcohol.

Nos. 2, 4, 6, 7, and 8 were not treated.

June 19th.

No. 1. Every trace of the formation of fungi had disappeared.

Nos. 2, 4, 6, 7, 8 exhibited, as did No. 10, fine fungous formations.

Nos. 3, 5, 11, 12, 13, no fresh fungi—the old ones had shrivelled up.

No. 9 still preserving its former protective power.

The practical result which we may draw from these experiments is the following:

The tar-ointment approved and used from remote times in various diseases of the skin is evidently an excellent parasiticide, and we have only to regret that it acts no further than on the parts which have come into direct contact with it, and which have been rubbed over with it. It is therefore improbable that it reaches the spores seated in the fissures of the skin, or destroys those which are located in the follicles of the hair.

Solutions of the principal remedies recommended against vegetable parasites are all of them objectionable, as the adipose tissue of the skin renders the surrounding of the parasitical elements still more difficult by their use. Their chief value consists in removing mechanically the spores, and thus restricting the spread of the parasites—a result which may be attained still easier and less dangerously by treating the parasite on the external skin with fresh water alone. The benefit of corrosive sublimate, acetate of copper, and tannin, as proved by experience, can only be indirect, by producing in the liquids of the animal soil a change (perhaps a coagulation of the albumen, and an envelopment of the fungous elements, which prevents their spreading further, or other influence hitherto unknown) in consequence of which the parasites finally retire.

It seems to be desirable to repeat the experiments with alcohol and alcoholic solutions. *Tinct. Veratri albi* has been used successfully for a long time against *Microsporon furfur*, i. e., the fungus of *Pityriasis versicolor*; and was successfully employed by myself in a very delicate case. I believe that alcohol and water alone would be efficient, as is shown by the above experiments. It all depends, *in praxi*, upon the greater or lesser dilution of the alcohol, so as to avoid irritation and pain; and, further, on the degree of dilution, so as not to destroy the parasiticidal effect of the remedy. Spirits and spirituous preparations being able to penetrate into the crevices, furrows, and fissures of the skin over the fungous elements, and, especially after proper cleansing and removing of the oily matter of the skin by means of soap, promise to supply us with the means of searching out the spores of the fungus even in its remotest corners, and of annihilating them. Practice must decide whether they will be able to set aside the very painful process of epilation, or, at least, to moderate it essentially. I am unable to say how much is owing to the cold produced by the evaporation of the alcohol in alcoholic preparations; but I would draw the attention, finally, to two points. First; nobody repeating the above experiments, confirming them, or who believes them on my authority, will ever doubt the efficiency of alcohol in these cases, or will prescribe for them anything but pure alcohol mixed with water. Secondly; I would ascribe a double effect to the wine given to children attacked by fungi: first, a direct, parasiticidal effect on already existing parasites; and next, an indirect effect by destroying the matrix favorable to the

formation of parasites, by generally improving and strengthening the constitution.

I should feel rejoiced if the officers of hospitals and private institutions devoted to skin diseases would test the results which I have mentioned here, since my own practice does not offer me sufficient material and cases enough bearing upon diseases of the skin.

I have abandoned the plan of writing a complete literary index. A rich literature is found in Diesing's work. In order to satisfy, however, the practitioner, I intend to give, if possible, in a short time, a literary index merely relating to the human parasites, and which will be sold for a few pence. Here it is only my duty to remind the reader that I have always mentioned the authors when speaking of their labours, in order to avoid the appearance of passing off for my own observations those which in reality are the property of others. None have been passed over intentionally: if it should, however, have happened accidentally, I beg to express here my sincere regret.

Vogt's 'Zoological Letters,' Weber's 'Illustrated Natural History,' and Martini's 'Hand-book of the Animals of Importance in Medicine' have chiefly been followed in the last part of the first division of this work. I beg also to thank Dr. Wagner, of Leipsic, and Drs. and Professors Virchow, Luschka, and Leuckart for the many valuable suggestions I have received from them.

And, now, may this book meet the judgment of the critic—may it be severe but just; perhaps the author may claim some consideration from having been obliged, far from any metropolis of science, to spend much time and to undergo much trouble in procuring the sources of his information, and has not in many cases been able to succeed. The book has no doubt many defects, and if one thing more than another could cause his regret on parting with it, it is the conviction that it will easily be seen on closer examination that the book is the work of an autodidactician. May the learning youth of my country fare better with regard to the science treated of in these pages than I did during my earliest studies.

APPENDIX BY TRANSLATOR.

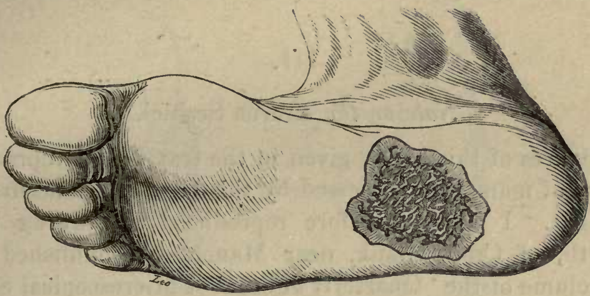
Appendix A, relating to the Acarina.

I.

The case referred to in the text (p. 64), in which a species of *Acarus* was found beneath the cuticle surrounding a sore in the sole of the foot of a negro, is related in the 'Microscopical Journal,' vol. ii, p. 65, pl. iv, fig. 7, 1842.

The man was admitted into the Seaman's Hospital with large sores on the sole of the feet, of a very peculiar character. The appearance of the sores conveyed the impression that more or less circular portions of the enormously thick cuticle had been gnawed or cut out, leaving the surface of the corion exposed and covered with prominent papillæ, and affording a sanious discharge. The border of cuticle surrounding these excavations was undermined, as it were, by irregular galleries, which penetrated to some distance between the cuticle and corion, or rather in the soft deep layer of the cuticle. On examining the secretion of one of these sores, Mr. Busk noticed the *Acarus* in question, which was dead, and apparently partially crushed, as represented in the figure. It was supposed that the disease, for which no other obvious cause existed, and which was undoubtedly of a peculiar character, might have been caused by the burrowing of these creatures beneath the thick cuticle, which thus became irregularly detached, being, as it were, undermined by galleries branching in all directions. The disease was attributed by the man himself to the wearing of a pair of shoes which he had lent to another negro, whose feet had been similarly affected for nearly a year, and who wore the shoes thus lent for a day or two. The negro, whose feet were affected in the way described,

was a native of the West Indies, but the man to whom he had lent the shoes came from Sierra Leone; and this circumstance was considered very remarkable in conjunction with the fact, that in some water brought by Dr. Stanger from the river Sinae,



on the coast of Africa, one very nearly perfect specimen, and fragments of others, very similar to, if not identical with, the one noticed in the negro's foot, were found. Whence it was supposed that the disease was contracted from some external source.

In this account of the case, though necessarily imperfect, there does not appear to be anything very "mystical," and still less does it seem to deserve the term "nerdachtig," so needlessly applied to it by Dr. Küchenmeister.

II.

Whilst remaining at the village of Ambaca, on the east coast of Africa, Dr. Livingstone, in his 'Missionary Travels in South Africa,' gives the following account of the attacks of an insect belonging to the group of *Acaridæ* :

"When sleeping in the house of the Commandant, an insect well known in the southern country by the name of Tampan, bit my foot. It is a kind of tick, and chooses, by preference, the parts between the fingers or toes, for inflicting its bite. It is seen from the size of a pin's head to that of a pea, and is common in all the native huts in this country. It sucks the blood until quite full, and is then of a dark-blue colour, and its skin so tough and yielding that it is impossible to burst it by any amount of squeezing with the fingers. I had felt the effects of its bite in former years, and eschewed all native huts ever after; but as I was here again assailed in a European house, I shall detail the effects of the bite. These are, a tingling sensation of mingled pain and itching, which commences ascending the limb until the poison imbibed reaches the abdomen, where it soon causes violent vomiting and purging. When these effects do not follow, as we found afterwards at Tete, fever sets in; and I was assured

by intelligent Portuguese there that death has sometimes been the result of this fever. The anxiety my friends at Tete manifested to keep my men out of the reach of the tampans of the village, made it evident that they had seen cause to dread this insignificant insect. The only inconvenience I afterwards suffered from this bite was the continuance of the tingling sensation in the point bitten for about a week."—Pp. 382-3.

III.

Note on the Acarus Scabiei.

The figures of this insect given in the text do not represent the two pairs of mandibles possessed by this creature so accurately as they ought. I have therefore reproduced a drawing by Mr. Hepworth, of Crofts Bank, near Manchester, published in the fourth volume of the 'Quarterly Journal of Microscopical Science.' Fig. 1 represents a magnified view of the entire creature, magnified 65 diameters.

Fig. 1.

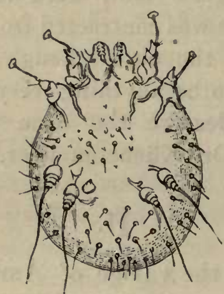
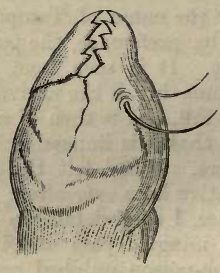


Fig. 2 is one of the mandibles of this creature, magnified

Fig. 2.



65 diameters. The mandibles of the whole family of *Acaridæ*

appear to afford good characteristic distinctions of the species. Figs. 3 and 4 are the mandibles of the male and female of *Acarus Sacchari,* magnified 390 diameters.

Fig. 3.

Female.

Fig. 4.

Male.

Appendix B, relating to the Insecta.

I.

The following note by the Author occurs in the second edition of the German work, and was omitted under the head of the *Brachycera,* to which it refers:

"I may also mention here a few facts derived from comparative anatomy and pathology. The most common therapeutics in cases of *Œstrus Ovis* in the frontal sinus are incision or trepanning of the frontal sinus, and removal of the larvæ by means of injections, or by means of a pair of pincers. I, for my part, consider such proceedings only justified after having found sternutatories (*e.g.*, the so-called Schneeberger snuff, or a kind of snuff prepared from *Marum verum,* mixed with finely powdered insect-powder) of no avail, and in case the larvæ of the Œstrus remained unremoved. It is of common occurrence that the larvæ of Œstrus are found sneezed out on the pasture land in spring time. We ought to imitate this process of nature, based upon the natural history of the *Œstridæ.* The above sternutatory, mixed with insect-powder, as the means for killing larvæ, has proved very effective during the last year. The observations which Bruckmüller made on a young vertiginous colt are very

remarkable. He found two larvæ of insects, 12′′ in length and 3′′′ in thickness, in the left hemisphere in front of the *pons varolii*, and higher up in the medullary substance of the brain. The rings of the larvæ were impressed upon the brain. (Vienna, 'Quarterly Journal for Veterinary Science,' 1855, vi, p. 48.)

Mention is made in Grävell's 'Notes,' viii, 1856, pp. 443—445, of the occurrence of the larvæ of Chrysomelines, Stratyomides, *Dermestes lardarius*, *Cartèles Scolopendron*, in the frontal sinus, to which I would draw attention, because the phenomena resemble those which manifest themselves after *Œstrus Ovis* in sheep. I therefore give a place to Grävell's note.

"Delasiauve describes a case, observed by Dumesnil and Legrand-Desaulle, of *hystero-epilepsy*, in consequence of larvæ in the sinus frontales, which is worthy of special notice on account of the accessory circumstances. A girl, nine years old, of a lively disposition of mind and in excellent health, was, one day in the month of October, 1850, suddenly seized by a violent pain in the region of the forehead, which was most severe over the sinus. Photophobia, vertigo, titillation on the nasal mucous skin and repeated sneezing, soon appeared. This state lasted for six weeks without remission. The child, who had always been of a sweet temper and obedient, became irritable and passionate, insulting her parents in a rude manner, breaking everything that came under her fingers, beating her playmates, &c. Her irritability, however, soon gave way, and the sick child became more quiet, complaining of a peculiar heat between the eyebrows, and asserting that she had passed small grains and animals on sneezing. These bodies passed off from the patient for nearly two months without creating uneasiness in her mind or that of her mother. Professor Brulle, at Dijon, examined the insects, and discovered larvæ of five different kinds, viz., Chrysomelines, Stratyomides, *Dermestes lardarius*, Castèles, Scolopendron. The attacks became worse in spite of the means employed. The sick child suddenly lost its consciousness on the 25th of March, 1851; and scarcely had she recovered it when she fell into convulsions, which lasted for several hours. Twelve leeches were put on in the afternoon, and although the attacks did not repeat themselves, the patient was brought on the 28th of April to the lunatic asylum of the department of the Côte d'Or. The secretion of the nose contained no larvæ for the next four days. On the 29th, at ten o'clock in the morning, just when the patient was going to carry a spoonful of soup to her lips, she uttered a faint cry, fell from the chair, and was seized by convulsions. The face became of a violet colour; the jaws were closed, the bulbi turned inwardly, the contracted muscles were quivering; her pulse beating rapidly yet feebly; her respiration became asthmatical, and her throat distinctly contracted. Seven similar attacks followed one another at short intervals, and each left the child exhausted, pale, and her eye lustreless. It was in vain to apply sinapisms, cold compresses, and varying doses of chloroform. Forty-five attacks were counted, lasting from one to three minutes, when the patient became at last more quiet and fell asleep. After her awakening on the evening and during the night following she again became subjected to disconnected movements. A warm bath of 26° C. (78° Fah.), together with cold douches, were ineffective. May 1st. Another bath of three hours' duration; ten drops of

Tinct. Cantharidum in a mixture. May 2d. In the secreted nasal mucus were found several larvæ, which repeatedly showed themselves during the fortnight following. The nervous affection was now clearly attributable to insects which had developed themselves in the sinus frontales. Dumesnil was of opinion that unsized paper dipped into a solution of two grammes of arseniate of soda in thirty grammes of distilled water, and rolled into cigarettes, should be given the girl to smoke, advising her at the same time to draw in the smoke through the nostrils. These fumigations rather excited the patient, and intoxicated her momentarily; they were, nevertheless, repeated every morning and evening. The baths and mixture of cantharides were likewise continued. Up to the 23d of May no new attack occurred. On that day Legrand witnessed thirty-three attacks, which were accompanied, like the first, by mental aberration. The treatment was now suspended for two days. May 30th. Several withered larvæ made their appearance, June 10th. Numerous larvæ. June 15th. Two convulsive attacks, but without mental aberration. July 14th. Symptoms satisfactory; slight sensation of heat between the eyebrows. The patient smoked four cigars. The tincture of cantharides was suspended on account of dysury. July 15th. After a thunderstorm and a walk in the town, five slight attacks. From that time up to her leaving the asylum, November 8th, her health remained undisturbed. No return took place for three years and a half. Each cigarette contained about 0·050 milligramme of the arseniate. ('Gaz. Hebdom.,' Sept. 28th.—Austrian periodical for Kinderheilkunde, i, 2.)"

II.

The account given by Dr. Livingstone, in his 'Missionary Researches in South Africa,' of the Tsetse, a dipterous insect producing ravages amongst cattle, is of sufficient interest to be repeated here:

"A few remarks on the tsetse, or *Glossiva morsitans*, may here be appropriate. It is not much larger than the common housefly, and is nearly of the same brown colour as the common honey-bee; the after part of the body has three or four yellow bars across it; the wings project beyond this part considerably, and it is remarkably alert, avoiding most dexterously all attempts to capture it with the hand, at common temperatures; in the cool of the mornings and evenings it is less agile. Its peculiar buzz when once heard can never be forgotten by the traveller whose means of locomotion are domestic animals; for it is well known that the bite of this poisonous insect is certain death to the ox, horse, and dog. In this journey, though we were not aware of any great number having at any time lighted on our cattle, we lost forty-three fine oxen by its bite. We watched the animals carefully, and believe that not a score of flies were ever upon them.

"A most remarkable feature in the bite of the 'tsetse' is its perfect harmlessness in man and wild animals, and even calves as long as they continue to suck the cows.

"We never experienced the slightest injury from them ourselves, personally, although we lived two months in their 'habitat,' which was in this case as sharply defined as in many others, for the south bank of the Chobe was infested by them, and the northern bank, where our cattle were placed, only fifty yards distant, contained not a single specimen. This was the more remarkable, as we often saw natives carrying over raw meat to the opposite bank, with many tsetse settled upon it.

"The poison does not seem to be injected by a sting, or by ova placed beneath the skin, for, when one is allowed to feed freely on the hand, it is seen to insert the middle prong of three portions, into which the proboscis divides, somewhat deeply into the true skin: it then draws it out a little way, and it assumes a crimson colour as the mandibles come into brisk operation. The previously shrunken belly swells out; and, if left undisturbed, the fly quietly departs when it is full. A slight aching irritation follows, but not more than the bite of a mosquito. In the ox this same bite produces no more immediate effects than in man, it does not startle him as the 'gadfly' does; but a few days afterwards the following symptoms supervene: the eye and nose begin to run, the coat stares as if the animal were cold; a swelling appears under the jaw, and sometimes at the navel; and, though the animal continues to graze, emaciation commences, accompanied by flaccidity of the muscles, and this proceeds unchecked until, perhaps months afterwards, purging comes on, and the animal, no longer able to graze, perishes in a state of extreme exhaustion. Those which are in good condition often perish soon after the bite is inflicted; with blindness and staggering, as if the brain were affected by it. Sudden changes of temperature produced by falls of rain seem to hasten the progress of the complaint, but in general the emaciation goes on uninterruptedly for months, and, do what we will, the poor animals perish miserably.

"When opened, the cellular tissue on the surface of the body beneath the skin is seen to be injected with air, as if a quantity of soap bubbles were scattered over it, or a dishonest awkward butcher had been trying to make it look fat. The fat is of a greenish-yellow colour, and of an oily consistence. All the muscles are flabby, and the heart often so soft that the fingers may be made to meet through it. The lungs and liver partake of the disease. The stomach and bowels are pale and empty, and the gall-bladder is distended with bile.

"These symptoms seem to indicate, what is probably the case, a poison in the blood, the germ of which enters when the proboscis is inserted to draw blood.

"The poison-germ, contained in a bulb at the root of the proboscis, seems capable, although very minute in quantity, of reproducing itself, for the blood after death by tsetse is very small in quantity, and scarcely stains the hands in dissection.

"I shall have, by and by, to mention another insect, which by the same operation produces in the human subject both vomiting and purging.

"The mule, ass, and goat enjoy the same immunity from the tsetse as man and the game. Many large tribes on the Zambesi can keep no domestic animals except the goat, in consequence of the scourge existing in their country.

"Our children were frequently bitten, yet suffered no harm; and we saw

around us numbers of zebras, buffaloes, pigs, pallahs and other antelopes, feeding quietly in the very habitat of the tsetse, yet as undisturbed by its bite as oxen are when they first receive the fatal poison. There is not so much difference in the natures of the horse and zebra, the buffalo and ox, the sheep and antelope, as to afford any satisfactory explanation of this phenomenon. Is a man not as much a domestic animal as a dog? The curious feature in the case, that dogs perish though fed on milk, whereas the calves escape so long as they continue sucking, made us imagine that the mischief might be produced by some *plant* in the locality, and not by 'tsetse;' but Major Vardon, of the Madras army, settled that point by riding a horse up a small hill infested by the insect without allowing him to graze; and though he only remained long enough to take a view of the country, and catch some specimens of tsetse on the animal, in ten days afterwards the horse was dead. The well-known disgust which the tsetse shows to animal excreta, as exhibited when a village is placed in its habitat, has been observed and turned to account by some of the doctors. They mix droppings of animals with human milk and some medicines together, and smear the animals that are about to pass through a tsetse district; but this, though it proves a preventive at the time, is not permanent. There is no cure yet known for the disease. A careless herdsman, allowing a large number of cattle to stray into a tsetse district, loses all but the calves; and Sebituani once lost nearly the entire cattle of his tribe—very many thousands—by its influence. Inoculation does not ensure immunity, as animals which have been slightly bitten in one year may perish by a greater number of bites in the next; but it is probable, that with the increase of guns, the game will perish, as has happened in the south, and the tsetse, deprived of food, may become extinct simultaneously with the larger animals."

III.

The following case from 'The Lancet' is given by the author as an appendix to the *Nemocera*.

"On Filamentous (Entozoon) Worms in the Living Human Body.
By Jonathan Green, M.D.

"In the months of May and June, 1843, were published in 'The Lancet' two papers of mine on 'Entozoon Worms inhabiting the Living Body.' These papers, I believe, occasioned doubts in the minds of some professional gentlemen, amounting more or less to a want of credence in the facts stated therein. This I in some degree anticipated, as such cases are extremely rare in this country, so much so that most practitioners pass through professional life without ever having seen a case of entozoon worms inhabiting the tissues of the human body, and it is the only case of the kind that I ever saw. In one of those papers I promised that if I was ever enabled to throw more light on this condition of disease, I should, through your pages, avail myself of the opportunity of doing so.

"Such an opportunity has occurred through the kindness of Professor Grant, of the London University College, himself a high authority in these matters. Dr. Grant has lately put into my hands the work of Professor Biagio Gastaldi, of Turin, in which the subject of entozoa and other worms is embraced and discussed by a master mind. In thus redeeming my promise, I would refer those of the profession curious in this subject, for full elucidation, to the pages of the able and practised authority of Dr. Gastaldi; and as some may not have the leisure to turn back to the before-named two papers, I will here briefly recapitulate the essentials of the rare case—entozoon worms inhabiting the living body—as detailed in 'The Lancet' of May and June, 1843.

"The lady who was the subject of the infliction I never knew anything of; she came to my establishment, as it were, determined not to be recognised, wrapped up in a shawl, veil, &c., and merely asked for a sulphur fumigating bath. She never said who she was, nor did she name any medical gentlemen that had recommended her to take the fumigations. She merely told the female attendant that she had been under the treatment of the first medical authorities of the west end of London; that they had done her no good, and that she was determined of her own accord to try the sulphur fumigations, and did not say what was the nature of her malady. On the evening of the day that she took her first fumigating bath, the attendant (a more than usually clever, experienced woman) came to me, saying she had that day had a very curious and not pleasant case—that the patient was all over worms, and that she saw them creeping from the patient's forehead and face whilst she was in the bath. I answered abruptly, by telling her not to talk such nonsense; she, however, seemed to maintain that she was right.

"On the patient repeating the bath, the attendant came to me with the same tale, and was again reproved by me; on which she said she was correct in her statement, and added, that she did not like to attend such a patient, as she herself might catch the disease; however, being a reasonable woman, her objection was overruled. The lady had her second bath, and the former report was repeated, with some enlargement.

"On taking the third bath, the attendant told the lady that she had named the case to me, and that I had twice scolded her for talking such nonsense, on which the patient said, 'that was like all the doctors; they won't believe it.'

"On coming out of the fourth fumigation, there was such a very, very numerous escape of worms, that the attendant again became uneasy, and I suppose some discussion took place between her and the patient. The result was, that the latter sent me word 'that, as I would not believe, I might come down and judge for myself.' I did so, and never was more surprised; there stood the patient *en chemise*. I was cautioned as I entered the room not to tread on the worms, and at once saw a round ring of pinkish-white on the floor; these were worms which had fallen from under the chemise, and had not been swept up, in order that I might see them. The lady's head, face, and chest, were covered with the shawl and veil; she seemed afraid of being recognised. On removing part of the veil from the forehead, then wreaking with perspiration, I saw little red points sticking out from the skin at right angles, and whilst looking at them some seemed to retract themselves, others evidently were getting longer, and became a

quarter of an inch and more in length, and then fell on the chest and to the floor as others had done. I then held aside more of the veil from the face, ear, and neck; there was the same appearance of little pink thread-like worms, as thick as they could cluster, elongating themselves to get out of the skin, and then falling, as from the forehead, on the floor. Many of them seemed to give a sort of jump or jerk before they could escape and fall from the person. The lady became more emboldened, and I was allowed to remove the shawl from the neck and chest, and afterwards from the arms, legs, &c.; but from all parts of the person these worms were sticking out, stretching themselves, and then with a positive jump escaping from the skin to the distance of six or eight inches, occasioning me to stand at a distance, in order that they might not fall or spring on to myself. With the corner of a napkin I carefully wiped various parts of the skin where I saw the worms sticking out, but I could not wipe them away, though gently, without breaking off the heads; and of those that had become more elongated and protruding from the skin, they would break short off, the bodies being very tender; whilst the gentle pressure of the napkin seemed to greatly facilitate and aid the escape of others, and very many were full an inch in length, yet for the most part they were from a quarter to three quarters of an inch in length, and some more, looking like pink thin threads. They were annular and transparent, with red heads, and the tail part was larger than the head part. They lived only a few minutes after escaping from the skin, wriggling themselves as worms do, and almost invariably curled themselves into a crescent or horseshoe form, then, taking a spring to many inches' distance, fell quite straight and dead, and the red heads in that short time would become dark brown, approaching black in colour. The napkin with which I had wiped the parts of the person I placed on a table, and having occasion to take it up again from its folds, the table under it was covered with these worms. I gathered about two or three table-spoonfuls of them, which were afterwards subjected to investigation, as detailed in 'The Lancet' of June, 1843.

"The case being so unique I delayed publishing it, until a correspondent of 'The Lancet' made an inquiry 'whether there was a disease of the skin, where living animals or insects were turned out.' This mainly determined the recordation of the case.

"Such cases, though so rare, I find are common enough in warmer climates, although I myself never saw a similar case of entozoa in those climes; but they must be well known to physiologists.

"It is satisfactory to know, at least as far as this case goes to establish the fact, that in the sulphur fumigating baths, and perhaps other mineral fumigating baths, we have a positive and direct remedy for such ailments, and which I think may be thus easily explained: The moisture and heat of these baths softening and laxing the skin, the worms more easily get to the surface, whilst the sulphur (or perhaps other minerals) that are used in the baths would make their position there untenable, and they are readily enabled to escape from the skin.

"The lady whose case is just related was very desirous of getting well of her odious complaint, as she called it; it was a sad source of annoyance to her husband, as the worms were constantly escaping on to the pillows and sheets and had been so doing for more than two years. She attributed,

as the cause of the complaint, her having fallen asleep in the air near some stagnant water, and on waking found her mouth and nose full, as she said, of young gnats. I suppose she got well, for after a few more baths I never heard anything more of her, which I judge I should have done had she not got well, for certain it is, she found a direct and powerful remedy in the use of the fumigations for dislodging these worms, not in hundreds, but I may safely say in thousands.

IV.

On the Minute Anatomy of the Larva of Anthomyia canicularis, *Meigen.* By Arthur Farre, M.D., F.R.S.

(Read before the Microscopical Society, April 28th, 1841.)

"The subject of the present memoir has come under my notice as a parasite of the human body, of which, however, it appears to be a rare inhabitant, as I have met with but a single instance of the kind, and I believe there are only two or three similar cases on record.

"The mere circumstance, however, of this insect in its larva state being found in the human intestine, it is not now so much my object to record, as it is to bring before the Society a brief description of the minute anatomy of this singular parasite, with a view of showing the peculiar adaptation of its organs, particularly those of the digestive system, to the circumstances in which it is thus occasionally placed.

"The insect considered as a parasite appears to have its parallel in the *Œstrus* or *bot* of the horse and sheep, and may perhaps be considered as constituting the bot of the human subject, though it does not appear to be altogether limited to man, but has been also observed to occur in the *Boa constrictor*.[1]

"The case which afforded me the opportunity of making the following observations was that of a rather sickly child, a girl five years of age, who was brought as an out-patient to St. Bartholomew's Hospital, in the month of June, 1837, having the ordinary symptoms of irritation produced by worms, for which a brisk purgative was prescribed. This had the effect of bringing away a vast quantity of the parasites, which were stated to be alive at the time they were passed, and were described by the parent of the child as coming away by handfuls at a time, and which continued to be passed at intervals for three weeks, when the case was lost sight of.

"A similar case occurred to Dr. Haviland of Cambridge, in the year 1836, in the person of a clergyman seventy years of age, who, after suffering disagreeable sensations about the epigastrium, which he described as a tremulous motion, accompanied by loss of appetite and general weakness, passed in the summer and autumn of the same year very large quantities of the larvæ, and, according to his own statement, the chamber-vessel was sometimes half full, and he thinks that altogether he must have passed

[1] See 'Lancet,' vol. ii, 1839-40, p. 638.

several quarts: they were alive, and continued to be passed for several months. This case is recorded by the Rev. Leonard Jenyns, in the 'Transactions of the Entomological Society,' vol. ii, part 3, and is accompanied by a very accurate figure of the insect. A rather rude drawing of evidently the same insect also accompanies a paper by Dr. Bateman in the seventh volume of the 'Edinburgh Medical and Surgical Journal,' p. 48, on the subject of larvæ found in the human body; while a much older, though more accurate one, will be found in Swammerdam's 'Bibl. Nat.,' tab. 38, figs. 3 and 4. And, lastly, may be mentioned a case published in the second volume of the 'Memoirs of the Medical Society of London,' which appears to be of a similar kind. These are the only cases that I find recorded of the occurrence of the larva in the human subject, but it has also been observed in the *Boa constrictor*, as appears from an instance recorded by Mr. Iliff, to which I have just alluded, and where the larvæ were passed along with the masses of urate of ammonia, which constitute the excrement of that animal.

"There appears to be little doubt that in all these cases the insect is the same, and that it is the larva of the *Anthomyia canicularis* of Meigen, or *Musca canicularis* of Linnæus.

"Its minute anatomy does not appear to have been investigated, and it is this deficiency which I shall attempt to supply from my notes of the dissection of the specimens obtained from the first case to which I alluded.[1]

"The larva is five lines in length by one and a half in breadth. It is of a dull-brown or blackish-brown colour, soft and flexible, but having a tough integument, which, however, is sufficiently transparent to allow of the alimentary canal being seen through it. The body consists of eleven segments, but the last is apparently formed of three blended into one. Each segment carries a pair of feathery branchial appendages, which project at right angles from the body, constituting a double row on either side. There is also a double row of small eminences extending down the dorsal surface, but the abdominal surface is nearly smooth. The lateral appendages, of which the upper series is much larger than the lower, are pinnate. The central shaft of these, which is long and pointed, is hollow, and communicates apparently with the tracheæ. The lateral pinnæ are again pinnated on their outer margin. The integument, which appears smooth to the naked eye, is found, when examined under the microscope, to be granulated all over with minute dentiform or pointed processes, which appear to be of a harder nature than the rest of the tegument, and resemble on a small scale the spinous prominences in the tegument of certain cartilaginous fishes, as the sturgeon; and it appears to be only an extraordinary development of these latter processes which constitutes the long feathery lateral appendages already described.

"The mouth of this larva is perhaps the most interesting part of its anatomy. The head is furnished with two broad fleshy lips, which together constitute a broad disc, having in its centre a minute aperture leading to the œsophagus, and flanked on either side by the hook-shaped mandibles, the sharp points of which are directed downwards and somewhat outwards, and are nearly retracted each within a separate sheath, the

[1] For a specimen of this larva consult the Museum of the Royal College of Surgeons, London; 'Cat. Nat. Hist. Series,' part iv, No. 609, D.

aperture in the extremity of which just allows their points to protrude. Each of these broad fleshy lips is crossed by transverse parallel plaits or folds of membrane, about twenty-five in number, which in their free margin exhibit a delicately notched appearance, and in fact in every particular resemble a similar structure which is seen on a larger scale in the sucking disc situated upon the dorsum of the head of the *Remora*, by which that fish is enabled to attach itself firmly to various objects. In the present instance, however, the structure, though precisely similar, is exceedingly delicate, and so minute as to be invisible to the naked eye, though there can be no doubt that it is intended to answer the same purpose in both. For by the aid of this sucker the larva is enabled to fix the head, so as the more readily to insert its sharp hook-shaped mandibles into the soft mucous membrane of the intestine which it inhabits, and draw therefrom its nutrient juices, which would thus readily flow into the little aperture of the mouth, situated in the centre between the mandibles, assisted also by the partial vacuum which would thus be produced during the act of adhesion.

"The mandibles are sunk so deep between the two fleshy lips, having only the points projecting from the aperture of their investing sheaths, that it is necessary to disconnect them entirely from the soft parts before they can be accurately examined. They are placed parallel to each other, with their hooked points directed downwards, so as the more readily to be inserted. The mandibular apparatus on each side consists of three portions. The first portion is hooked and sharp pointed, and is only the $\frac{1}{60}$th of an inch in length. It is nevertheless furnished at its base with a delicately shaped ball, adapted accurately to a socket in the second joint, and has projecting from either side of its base a sharp spine or trochanter, for the insertion of the tendons of the abductor and adductor muscles by which its movements are effected. The second joint bears the socket to which the ball of the first is adapted, and at its opposite extremity is united to the third and principal portion of the jaws, which consists of a broad expanded corneous plate, of less density than the preceding, and resembling in form and office a similar structure well known as occupying the centre of the large claw of the lobster, being for the attachment of the muscles by which the mandibular hooks are moved to and fro. The whole mandibular apparatus measures about $\frac{1}{16}$th of an inch in length, and, being very firm and solid, presents a remarkable contrast in texture to the surrounding soft parts with which it is connected, and from which it is easily detached.

"If the body of the insect be laid open the alimentary canal is seen to be of considerable length, and much convoluted. It commences by an exceedingly delicate hair-like œsophagus, so narrow that it would appear to be specially destined to transmit fluid nourishment, and nothing else. This terminates about the third segment of the body in a minute globular cavity or proventriculus, which is of the same diameter as the rest of the alimentary canal, and immediately below which four very short salivary vessels enter. From this point commences the large intestiniform stomach, which after contracting in its first third to the finest thread, again dilates and proceeds of uniform diameter to the point where the four slender biliary vessels enter, where it again contracts and forms a short intestine. The whole alimentary canal is about six times the length of the body, and of this length the stomach forms about five

sixths. Its greatest diameter does not exceed one third of a line, and its least is that of a mere thread. The whole structure appears to be that of an animal adapted to live on fluid nourishment.

"The principal external openings to the tracheæ appear to be two apertures situated on the dorsum of the last segment of the body, and which constitute the last pair of the series of dorsal eminences formerly noticed. These apertures correspond with the very remarkable and conspicuous pair of organs occupying a similar situation in the last segment of the œstrus of the sheep, and which are also the external openings of the respiratory apparatus in that insect.

"None of the insects were alive when they came into my possession, and they were placed in spirit of wine for the purpose of preserving them previously to their being dissected. Several days after my attention had thus been directed to the subject, I happened to observe at the bottom of a jug of New River water a small living object, which appeared very much to resemble the larvæ which I had recently been examining; and upon placing this under the microscope I found the resemblance to be complete, except that the animal was only about two thirds the size of the former. It was deficient also in the pinnæ upon the lateral spines, which were simple, but the mandibular apparatus was perfectly formed. On making further search two other individuals of the same species were found in different stages of growth; the smallest, however, not exceeding one third of a line in length, though still possessing some of the characters of the larger ones. One of these specimens was very lively, moving freely at the bottom of the water, and frequently protruding and retracting its proboscis, by which it dragged itself along.

"This fact is a matter of some interest, as furnishing a clue to the source of these parasites, since it is evident that the larvæ can pass along the water-pipes which supply the metropolis, and may thus be swallowed in the water used for food: and in the present case the larvæ, or the ova, must have traversed a distance of at least a mile. At the same time it is evident that this cannot always afford an explanation of their mode of entrance into the body, because in the case of the clergyman at Cambridge, it is expressly stated that 'he never drank water unmixed, but generally beer, tea,' and the like; at the same time the water used for these beverages was entirely supplied from a pond on a stiff clay. If, therefore, the ova found entrance with the fluid aliments, they must have withstood the action of heat, as in making the beer, tea, &c.; while, on the other hand, it is difficult to suppose that they passed in with the solid food, because the larvæ are evidently aquatic. Perhaps the most inexplicable part of the case is, the fact of their occurrence in such immense numbers. In the Cambridge case several quarts were passed in a few months, and in the instance which I have just recorded they were described as coming away by handfuls. It is extremely difficult to account for this fact, because a number of larvæ, or their ova, must have been swallowed equal to those which were evacuated, since they could not multiply by generation in the alimentary canal, they being in the larva state, and having, as the dissection showed, and as is well known in the case of larvæ, the generative organs undeveloped; indeed, no trace of generative organs was visible: while it is difficult to suppose that the parent animal could have been accidently swallowed, and its ova, previously impregnated, have become

developed in the bowels; though this is perhaps the least objectionable supposition. At any rate the parent animal could not live in the alimentary canal, since the larva has been recognised by several entomologists as being that of a well-known fly (the *Anthomyia canicularis*). The latter supposition, however, which I have advanced, namely, that the fly, having its eggs previously impregnated, may have been swallowed, and thus, perishing in the digestive canal, have left the ova unencumbered, and in a possible situation for development, derives some countenance from the circumstance of the extreme rarity of the occurrence of these larvæ as parasites, there being, as I have mentioned, very few cases on record; which would give to the circumstance the air of an accidental occurrence, of which, however, it is again immediately robbed when we contemplate the singular and very obvious adaptation of its organization to the peculiar circumstances in which it is thus placed. The anatomy being clearly that of an animal destined, or at least adapted, to live by adhesion and suction on fluid nourishment, though it is clear from the fact of some being found nearly two thirds grown in simple river water, that the larva is also capable of life and growth in other elements than the contents of the alimentary canal, and in other capacities apparently than that of a parasite.

"Much, it appears, may be advanced on either side, and indeed the whole subject appears to me to be calculated to afford interesting points for discussion; and it is chiefly with this view that I have brought it before the notice of the Society."

Appendix C, relating to Vegetable Parasites.

I.

Appendix and Supplement to the Parasitic Plants, by the Author.

Page 121.—Kölliker and Scanzoni also found spare, thin, and short ferment-fungi in the secretions of the *Cervix uteri*.

Page 127.—*Treatment of Merismopœdia* (*Sarcina*) *Ventriculi.*—Hasse also, in his most recent 'Clinical Reports,' commends most of all nitrate of silver against this parasite, while he saw no benefit from the hyposulphite of soda. Would not strong spirituous drinks in moderate doses, as a spoonful of undiluted rum, once or twice daily, quickly swallowed, particularly when nothing else is drunk, be worth a trial?

Page 129.—First Donné ('Cours de Microsc.,' pp. 157—161, fig. 33), and after him Kölliker and Scanzoni (l. c., p. 12 and fig. 6), found in vaginal mucus fine, stiff threads, 0·04—

0·06′′ in length, exactly resembling *Leptothrix buccalis*, from which they are only distinguished in that they are always isolated, are not bound together by a fine granular material, and are never situated on epithelial cells. Although often very numerous, they are still not so abundant as *Trichomonas vaginalis*, and are never met with like these without the coexisting presence of mucus-corpuscles.

Page 132.—In his 'Clinical Reports' during 1853-4, pp. 69—71, Fuchs mentions having found a fungus, in *Bronchitis maligna*, in the sputa and bronchi. After written communications he considered it to be the fungus treated of before as *Leptomitus Hannoveri.*

Page 162.—*Correction and appendix to the notice given of the parasitic fungus mentioned by Fuchs.*—Through an oversight on my part it is said that *Alphi* are "white spots on the skin." I should have written white pustules in or on the skin. I shall seek to make this error good, because I speak more at detail now of Fuchs's fungus. The *Alphus sparsus* = scattered meal-scab = *Pustulæ scrofulosæ* = *Ecthyma scrofulosum* appears especially on the trunk and superior extremities, seldom on the face; solitary, discrete, light gray pustules, never met with on hairy parts; which raise themselves on isolated, round areolæ of the size of peas or beans; which are hard, firm, nearly half spherical, and buried in the pale livid œdematous halo; they are filled with a yellowish fluid, and from a pin-prick slowly flows out a fluid which resembles a mixture of chalk powder and water. They dry up without breaking into isolated round crusts, increasing to the size of a groschen-piece, which raise themselves over the skin and become easily torn off by the clothes, on which a circular scrofulous ulcer remains behind.

According to Fuchs this form of eruption is confined to scrofulous persons, and is contagious like favus, although the attempts at its inoculation by Fuchs failed. Through conditional modifications of the constitution, simple *Eczema, Impetigo, Psydracia flavescens, Ecthyma, Acne,* &c., may become very like *Alphus* externally.

That the deeper layers of the skin are involved is probable according to Fuchs, but has not been proved. The crust consists of fungus threads which in some measure resemble those of favus; they appear sometimes to be increased by epidermic scales, and occasionally assume a pale greenish colour.

This disease becomes chronic, has an indeterminate dura-

tion, but is not so protracted as favus. Recovery takes place of itself after the cicatrization of the ulcers and the falling off of the crusts; still relapses take place. It never has a bad termination.

Treatment.—According to Fuchs this should be antiscrofulous; still local means in addition are beneficial. Recent cases can be destroyed by caustic, treating the skin after the destruction of the crusts; with alkalies, sulphur, preparations of iodine, and, I believe, with spirit or spirit containing veratria; still one should not close up the ulcers too quickly. Fuchs believes the fungus is allied to favus. Possibly this form is the *Favi disseminati* of other authors.

Page 181.—*Treatment of Achorion Schoenleinii* (*Favus fungus*).—Shortly after the completion of the experiments mentioned at page 236, I sent them, with other communications which gave the same results, to Professor Hebra, with the request that he would, in his numerous experiments with spirituous remedies (with *Tinct. Veratri* or with pure spirit), carry them into effect against favus, and try whether the theoretical results gained by me were practically applicable. The distinguished skin-pathologist had the kindness immediately to make the trial on two of his patients in the following manner: After the way and mode of epilation given at page 185, Hebra treated the diseased parts with the following mixture from the 23d of June—℞ Spirit. Vini rctss. (80°) lb. j, containing Veratrini, gr. v. He soaked with this solution pieces of lint, and ordered the parts to be well rubbed with these twice a day, and then a dossil wetted with the tincture to be laid over them. In the middle of August the patients were dismissed; and, up to the end of October, had shown no relapse. The results appeared so satisfactory to Hebra, that he carried on this treatment directly with three new patients, and, in future, will adopt this treatment of favus, and with plain spirit. May his further experiments turn out as successful as the first! Whether this will succeed in entirely sparing the epilation is an object which I have sought to determine by the strict but always impartial and scientific criticism of the celebrated clinical observer of Vienna. But should the later experiments not succeed, still the experiments of Hebra should invite inquiry. The patients appear to be remarkably pleased with this treatment; at least those two patients mentioned here came only lately to Hebra to thank him specially for their recovery.

Only lately we find the confession made by Küchler (Official Report of the Hospital at Darmstadt in No. 38 of the 'German Klinik' for 1855) that, in spite of the pitch-plaster, he has experienced two relapses. That this extremely energetic physician did not, perhaps, proceed mildly in the application of the pitch-plaster, the following will show. I give this account because it indicates particularly the preparation and application of the pitch-plaster. One takes ordinary, not thin, liquid cobblers' wax, and places it not too thickly on strong, not too fine, nor too new, nor too smooth, nor very heavy linen, with the addition of a few drops of oil of turpentine. After the most thorough removal of the hair possible, as far as it goes, and after removal of the crust which becomes softened by oil, the pitch-plaster is placed on the diseased part, over all the space implicated. The plaster for two or three finger-breadths near its anterior border should be kept free from pitch and turned over, by which it can be better taken hold of and pulled off. Incisions also should be made round the edges of the plaster, by which it fits closer, but not too deep by which it is not pulled off afterwards. The pitch remains on eight days, and is then removed. The patient is seated on a stool without a back or crosswise, and his head and neck made fast sideways under the plaster by the grasp of a strong assistant. A second assistant at the head stands behind the patient, with his eight fingers on the fore part of the slightly loosened plaster, places his knee on the neck of the patient, and draws off, if possible, the whole plaster with a haul. This proceeding has sometimes to be gone over again. The stench on the removal is often horrible. The part never remains bare. Küchler saw relapses twice; still he has not specified altogether the number of cases. On the removal once all the pitch remained on the diseased part, because the assistant had taken very strong linen. Küchler ordered a smoothing iron to be heated, and better linen to be ironed on. With such faults, and such heroic *corrigentia*, who would not admire the pitch-cap treatment!

Page 202.—*On the question of Reubold. Is the thrush fungus peculiar to man?*—In October of this year, (1856), which distinguished itself by its mildness, and at a time when aphthæ frequently associate themselves on sloughing sores, I procured, from a boy twelve years of age, affected with inflammation of the neck (probably scarlatinous), from the country,

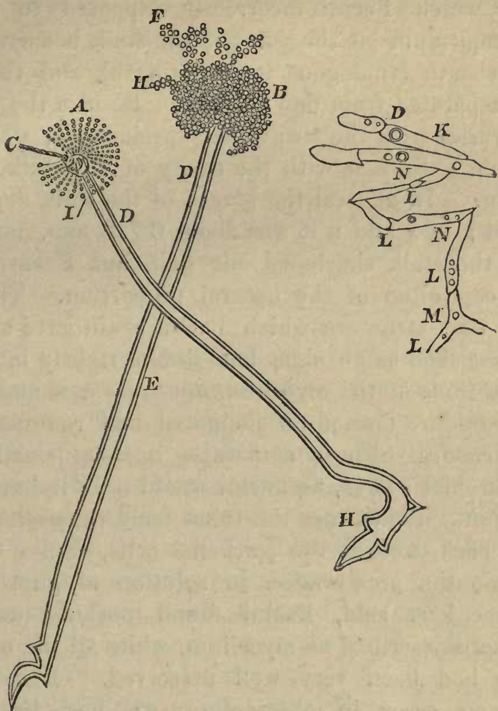
some pieces of aphthous membrane, in which I found numerous elements of the fungus. Of these pieces I placed a great number between the jaw-bones and cheeks of three still blind sucking puppies, where the fungus would support itself longer without becoming swallowed. I hoped in this case the sooner to resuscitate the fungus, because the puppies only a few hours before the inoculation had their ears and tails cut off, and the animals were brought down a little and were anæmic. But, although for fourteen days I examined the dogs every other day, still I could discover none of the aphthæ on any part of the mouth. Professor Haubner has informed me that he never saw aphthæ on young dogs. Should the external appearances after similar experiments be found in the mouths of sucking calves, Haubner, ought to state that he had produced aphthæ from fungi.

Page 225.—To the kindness of Professor Luschka I am indebted for my knowledge of the original labours of Pacini. Although Pacini certainly was incorrect if he meant that he had found two peculiar plants in the ear, and if he considered the figures K to N to be an alga resembling *Oidium albicans* and figures A to J a fungus. Robin is perfectly correct if he understood the figures K to N as the *mycelium* of A, so I am still, after comparison of the original and the version of Robin, necessitated to make these remarks. I mention only by the way that Robin allowed Dr. Bargellini's patients to go back to the sea-baths of Florence instead of those at Livorno.

The white fatty-looking masses in the ear—which entirely covered the tympanum, which only became visible when injections or other attempts to remove the fungus accidentally shifted a portion of the fungus on one side, and allowed a piece of the tympanum to come into view—consisted of granulations, mostly epidermic cells filled with fine granules, which were very transparent and uniform, and had a diameter from 0·015—0·018 mm., and of the elements of the fungus.

The capitulum of the fructifying elements was completely spherical, that of Mayer's ear fungus pear-shaped. The colour changed according to the size of the capitulum and according to its state of maturity; with advancing age and ripeness the head became darker, less transparent, and more indistinct in its structure. The placenta or the centre of the capitulum = the proper receptaculum, was of very varied dimensions; in figure A it measured 0·142 mm. 0·037 mm. in diameter, in smaller specimens it was of less size. This structure consists of

small spores (F), which in the stage of development (B) have a diameter of 0·0042 mm., if not so mature they are smaller,



in A 0·003 mm. The mature, perfectly spherical spores have a very thick contour, and are only a little more transparent in the centre. They range themselves in rows joined to one another, and radiate from the placenta. From this arrangement, Micheli conceived the name *Aspergillus* (*Aspersorio* = holy-water sprinkling.) Pacini wondered that neither Mayer nor Robin had represented this arrangement, but the spores are dispersed and the placenta is sown over with them, and believes that if it does arise not from inaccuracy of delineation, that certainly different species are treated of by Mayer and himself. But if perfect maturity has occurred the spores disunite themselves spontaneously, which, in example A amount to about 19,000, is deceiving.

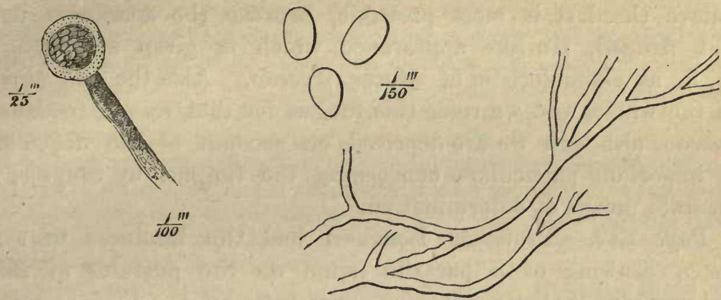
The *caules* = the filaments, which form the stalk, present the appearance and size of a large elementary nerve-fibre of the frog

with a double contour. Moreover, externally they are single in their course and of the same size, the *caules* sometimes being covered at their terminations with small, thorny-looking excrescences, which Pacini incorrectly supposed to be radicles. Near the capitulum (at the point J) the stalk is surrounded by a species of sheath (analogous to a perianth), and the individual spores are separated from one another. Besides the diameter of the *caulis* varies with the size of the specimen, in A the diameter is 0·013 mm. So it is with the cavity of the stalk, which in A is 0·008 mm. In general the length of the stalk depends on its development; in A and B it was about 0·770 mm. long. Pacini has drawn the stalk shortened one half, but I have given the stalk and capitulum of the natural proportion. The mycelium consists of that structure which Pacini again gave at K, and incorrectly described as an alga, but Robin rightly interpreted it. The ramifications of the mycelium one sees at M and L. Therefore these rows are formed on elongated and reunited cells, and exhibit internodes. Those containing in them small dark cells, but which are not spores, as Pacini would have it, have a diameter of 0·0015 mm. Sometimes the tubes bend themselves angularly and return back towards the epithelial cells, caules, and spores. After two months' preservation in solution of gum arabic with a little arsenious acid, Pacini found nothing more of the substance here described as mycelium, while all the other parts of the fungus had been very well preserved. Has Pacini here committed an error in observation, or has he overlooked altogether the mycelium?

The treatment consists not in dropping in acetate of lead, as Robin repeats, but in vigorously injecting water. The acetate of lead should be employed secondarily against the *Otorrhœa* which remains behind.

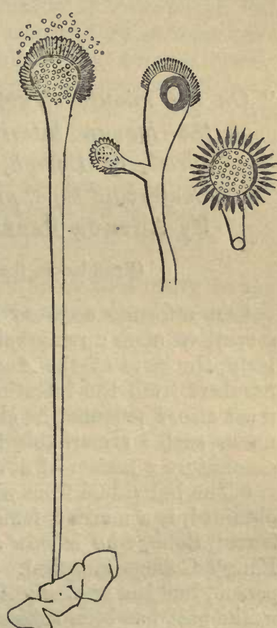
In regard to the position of Pacini's fungus in the system, I should not after my observations of Pacini's drawings have placed it with *Aspergillus,* as Robin did, but associated it with Sluyter's *Mucor mucedo,* so long as we in general allow, that every observer accurately observes, and has given drawings true to nature. The differences between *Aspergillus* and *Mucor mucedo* consist for the present in the dissimilar form of the so-called placenta and the filamentary radiated or homogeneous light simple ring forming the periphery of the capitulum, and these are possibly only differences in the age and maturity of the individual specimens. (See page 271).

What has been said concerning Pacini's fungus is also to be said concerning the fungus here mentioned, for the representation and description of which I am indebted to Professor R. Leuckart. The fungus was found in 1848 at Göttingen in the stomach of a dead



woman. The numerous ramifications of the threads had produced such a matting together, that a well-formed membrane was found on the mucous coat. The sporangia were $\frac{1}{25}'''$, the shaft or stalk $\frac{1}{100}'''$, the individual spores $\frac{1}{150}'''$ in diameter. The individual spores resembled yeast-cells. On the grounds mentioned above, for the present I shall give this fungus the name of *Aspergillus Leuckartii.*

Page 231.—*Mucor mucedo.*—Herr Hofrath Hasse in Heidelberg, had the kindness to send me, through Dr. Wagner of Leipzig, a fungus found in the interior of a gangrenous abscess of the lung. Dr. Welcker determined the following principal facts, which I can only corroborate by the microscopical preparation kindly sent me. It occurs in the form of thallus-threads about 0·308 mm. in length, by a breadth of from 0·0026 to 0·008 mm. The shaft always increases more in breadth towards the top = *sporangium,* till it attains in the round *sporangium* to a breadth of 0·025. mm. The stalk is hollow in the interior, so that if it is broken across, one can see within through its transparency, or if it becomes dried up in part, air finds its way into it, which is sometimes met with in the *sporangium* in the form of a small round bubble. The spores are 0·0036 to 40 mm. in length, and have in breadth a diameter of from 0·0015



to 17 mm. Sometimes placed on the side of the stalk is another smaller *sporangium* with only a short stalk.

From the external appearance it can only be considered an *Aspergillus,* similar to Mayer's ear-fungus or a *Mucor mucedo.* I believe the last is most probable, because the sporangia have that fringed, fan-like appearance which is given at Plate V, fig. 5, as characteristic of *Mucor mucedo.* Also the seat agrees on the whole, and we refer this fungus for that reason to *Mucor mucedo,* although we are deprived, on account of the deficiency in important particulars concerning the fungus, by Sluyter, of accurate means of determination.

Page 232.—Professor Leuckart had the kindness to send me a drawing of a parasite found on the pustules of *Acne* and granular contents. Its size varied between $\frac{1}{65}$—$\frac{1}{40}'''$. Leuckart represents the parasite with more than two articulations, always according to its size. I find once five, once seven, cross-partitions. However, the whole has a great resemblance to Ardtsten's *Puccinia.*

II.

" *On the minute structure of certain substances expelled from the human intestine, having the ordinary appearance of shreds of Lymph, but consisting entirely of filaments of a Confervoid type, probably belonging to the genus* Oscillatoria. By Arthur Farre, M.D., F.R.S.

(Read before the Microscopical Society, June 22d, 1842.)

" On a former occasion I laid before the Society the results of my observations upon a remarkable and exceedingly rare parasite of the human body, the larva of the *Anthomyia canicularis,* which was expelled in vast numbers from the intestine. The subject of the present communication must also, I presume, be classed under the head of parasites, but occurring under such a remarkable form, as to render the determination of its precise nature a matter of not very easy accomplishment.

" The individual from whom the substances which I shall describe were obtained, is a married female, aged thirty-five, residing at No. 28, Crown Street, Soho, who is now attending as an out-patient under my care, at King's College Hospital. She is a moderately stout and healthy-looking person, but has been slightly ailing for the last twelve months, and for six weeks past has been subject to menorrhagia, by which she has been somewhat debilitated; she has also suffered lately from slight dyspepsia. Six

days ago, after suffering considerable griping pains in the bowels, which continued for twelve hours, she passed *per anum* a number of shreds, which being discharged with some difficulty, and causing an obstruction of the bowel, her attention was thereby more particularly attracted, and some of the shreds were pulled away by herself, so that there can be no question as to the source whence they were derived.

"The substances thus passed were placed in water, and brought by the patient for my inspection. They had so much the appearance and ordinary characters of shreds of lymph, or false membrane, that I had not at that time the slightest suspicion of their being anything else, and merely reserved them for a more particular examination at some future period, but without any expectation that they would present appearances different from the ordinary microscopic characters of false membrane. I was therefore much surprised, on placing a small portion of the substance under the microscope, to find that it presented the appearance of a mass of *Conferva*, and that, in fact, the entire substance was made up of nothing else but tangled filaments of a confervoid type. However, before describing the microscopic characters of this singular substance, it will be necessary to give some idea of the appearance of the mass, as examined without the aid of the microscope. I have already compared the substances to shreds of lymph or false membrane; such shreds or flakes of soft yellow matter, assuming a membranous form, are familiar to every one accustomed to pathological researches. It is well known that they are often the result of inflammation attacking membranous surfaces, and that they are most frequently met with on the serous membranes, as the pleura, pericardium, and peritoneum, but that they are also occasionally, though more rarely, produced from mucous surfaces, as those which line the air-passages and alimentary canal. Of the same nature as these have been also generally considered those fibrinous flakes which are occasionally passed from the intestines in chronic affections of the mucous membrane of those parts, and which sometimes assume the form of tubular casts evidently moulded upon the surface of the gut; and lastly, I may allude to a more common affection of another mucous surface, the lining membrane of the uterus, on which membranous substances are occasionally formed and discharged, constituting a complete cast of the organ, and familiar to every practitioner as occurring occasionally in cases of dysmenorrhœa.

"I allude to these examples (familiar enough to medical men) for the purpose of showing to those who have not directed their attention to such subjects, that membranous or fibrinous substances are occasionally discharged from the various mucous surfaces of the body, which are generally considered to be the product of inflammation, either acute or chronic, and are closely allied in composition and ordinary characters to the fibrinous part of the blood, from which fluid they are apparently separated by the inflammatory process. With such knowledge therefore we should, I think, be but little prepared to find that flakes or shreds of a membranous substance—having so much of the ordinary appearance of the substances which I have just described, that several medical friends to whom I have shown them, have at once supposed them to be the ordinary flakes of false membrane discharged from the bowels—should, when microscopically examined, present all the characters of those confervoid masses which are

to be found in almost every water, but the appearance of which to the naked eye is so totally dissimilar to that of the substances under consideration, that no one could for a moment suppose, without the aid of the microscope, that they were, in the slightest degree, allied to each other.

"The several portions of this substance in my possession differ from each other in some respects in reference to their external characters, though in their composition all are alike. Some of the portions are in the form of riband-shaped masses, of which the largest is six inches in length, varying from half to three quarters of an inch in breadth, and is about a line in thickness: there are five or six portions of similar breadth and thickness, and varying from one to two inches in length. These portions are highly elastic, and may be stretched to a considerable length, returning again to their former shape with considerable resiliency. This elasticity, however, is chiefly observed when the pieces are stretched in the longitudinal direction, as they are capable of very little extension transversely. The margin of some of these portions is irregular and flocculent, being formed evidently of minute filaments, and resembling the villous surface of a mucous membrane, and in the largest piece the whole surface has this velvety appearance. Others of these portions present more distinct evidences of a fibrous arrangement, and distinct traces of fibres, or, as they will be presently shown to be, bundles of filaments, may be observed extending through the mass, both longitudinally and transversely, but the surface or the margins still preserving a flocculent appearance. One or two of these pieces, of which the border is nearly smooth, present very much an appearance of having been cast in a flattened or contracted portion of the small intestines; one of these especially, which is only four lines in width, looks like a portion of the intestine of some small animal, with its mucous membrane turned externally and flattened, but, like the other portions, it is not hollow, but riband-shaped. The remaining portions differ from these only in presenting no trace of the flocculent surface or margins, and in being more completely membranous. They might, in fact, be easily mistaken for portions of animal membrane, and being of a closer texture have much less elasticity than the former portions. The thinnest of these portions, which at its edge is nearly diaphanous, is very smooth and shining, having almost a tendinous lustre. To the naked eye it appears to be made up of fibres, both longitudinal and transverse, but the longitudinal prevail, and the mass more readily splits in that direction, the splitting taking place with a clean margin, as if cut with a sharp instrument. This fragment bears no distant resemblance to a piece of *dura mater*, covered by the arachnoid membrane; both surfaces are equally smooth, and no appearance is presented of any surface for attachment. The remaining portions are thicker, measuring nearly a line in thickness, and present a more distinct appearance of fibres crossing at right angles. They may, in fact, be readily split into masses of fibres, which very closely resemble, both in colour and texture, the middle or fibrous coat of the arteries, but being softer and more elastic. The whole of these portions are of a buff colour, and are here described as they appear when examined under water.

"When a small fragment of any of these masses is placed under the microscope, with an amplifying power of from 50 to 100 linear, it is seen to be made up of very delicate filaments, the $\frac{1}{7000}$ of an inch in diameter,

which are differently arranged in different specimens. In those portions which have a flocculent surface and loose texture, the filaments are seen to be coiled up and interwoven in a tangled mass, which presents no appearance of any definite arrangement: at the edges of such portions the filaments are seen distinct and separate from each other, and shooting free into the surrounding fluid; but the examination of the centre presents a confused appearance where the fibres cross each other in all directions, and intermingled with them are seen some irregular granules of the same colour as the mass. When those portions however are examined which have a *membranous* character, a very distinct and definite arrangement of the fibres is perceived, which here cross each other nearly at right angles, and are so interwoven as to form a layer of greater or less strength and thickness; and it is apparently entirely owing to this variety in the mode of arrangement of the fibres, that the different appearances in the several masses already described are produced: the tangled and confused aggregation of fibres producing the villous masses, the loose ends of the filaments constituting in fact the villosity, and the regular crossing of the fibres giving rise to the smooth, shining membranous expansion.

"To examine however the minute structure of these filaments, which make up, in fact, the whole mass of these singular substances, with the exception of the granules just noticed, and which are few in number, it is necessary to use a magnifying power of 500 or 600 linear.

"The filaments which have been just described, are so exceedingly minute, and require such high powers for their examination, that it must be a matter of some difficulty to determine their exact nature. The *confervoid* type however is, I think, so very strikingly and obviously exhibited, as to leave little room to doubt the class of products to which this substance is to be referred. That it is no animal membrane or product of inflammation, as it would at first sight appear to be, before it had been submitted to the test of the microscope, will, I think, be readily admitted by all who have ever had the opportunity of examining these substances. The texture to which perhaps it approaches most nearly is the *muscular*, and that in the invertebrate classes only, in many of which the filaments composing that texture are disconnected, and not bound up in bundles and enveloped in sheaths, as in the Vertebrata, to which, therefore, the arrangement here described can bear no resemblance; but the resemblance to muscular texture at once vanishes when we apply the higher power, and discover the intimate structure already described.

"If, as I presume will be the case, the product be admitted to belong to that group of Cryptogamic products which have been generally classed together under the title of *Confervæ*, it then remains to determine whether this specimen belongs to any known genus or species, or is as yet undescribed. I am inclined to refer it to the genus *Oscillatoria*, but am not acquainted with any *species* with which it is identical. Its resemblance to *Oscillatoria* is seen in the extreme delicacy of its filaments, in its simple transverse markings, and the separation of the green matter at intervals within the sheath by which those markings are produced. In colour it resembles *Oscillatoria ochracea*, but that species is extremely brittle, and can scarcely be handled without breaking up into fragments, while this is very tough and elastic. I am inclined to consider it a new species, if not a new genus.

"Further opportunities of examining this product, supposing it to be allied to or to belong to *Oscillatoria*, may probably throw some light on the disputed question of the animal or vegetable nature of that genus, which appears to be now one of the many bones of contention between the botanist and the zoologist. Perhaps the chemical analysis of this substance, which I have not yet had an opportunity of instituting, may throw some light upon the question. I have already alluded to the resemblance in colour and other particulars of this substance to animal matter; it appears also to be disposed to a similar putrefaction, for on opening the phial this morning, in which the substance was contained in a weak solution of salt and water, I perceived a very distinct odour, similar to that of decomposing animal matter, and I find that these specimens are not now so perfect as when I first examined them.

"With regard to the source from which these bodies could be derived: since similar organisms are abundant in every water there can be no difficulty in supposing that a portion of the substance itself, or some of its reproductive germs or sporules, may have been swallowed by this individual in the water which she drinks. I have made particular inquiry as to her diet, and find that it is of the ordinary description, both animal and vegetable; and that her drink is limited to tea and water, but of the latter she takes very little. The water is supplied by the ordinary service-pipes of the metropolis, and not from any particular well or pump.

"At this point of the inquiry the same difficulty occurs as in the question of the origin of the ordinary internal parasites of animals, the *Entozoa*. Whence are they derived, and how is their existence in the body to be explained by reference to an external origin, since they are not found in any other situation? It would be almost impossible to conceive that the substance which I have described could be found out of an organized body, for example in a stream of water; but I would suggest, that having derived its supplies of nourishment from an organized body (in this case, as may be presumed, from the surface of the intestine), its characters may have been so far modified, consisting in fact, as it does, of animal matter, as to render the object no longer recognisable as an already existing species.

"I believe the fact which I have just announced is new to science; I have not myself met with any similar instance, but it belongs to a class of facts which modern microscopic investigation is rapidly rendering familiar to all who value that species of observation. In the journals of the day may be found numerous examples of parasitic growth from various parts of the bodies of animals, and even of man. From the surface of the body, as in the confervoid growths attached to the fins and gills of fishes, and cryptogamic vegetation constituting the essential part of certain morbid products, as in the porrigo of the human subject. Other examples are recorded of internal vegetations, *Entophyta* as well as *Entozoa*, as from the lungs in birds, and even of the human subject, as recorded by Dr. J. H. Bennett, in a case where such organisms were expectorated by an individual under pulmonary consumption. Mr. Goodsir has related a case in which thousands of animals, allied to the genus *Gonium*, were vomited from the human stomach; and to the mass of evidence which is thus rapidly accumulating, of parasitic growths, both animal and vegetable,

infesting the bodies of man and animals, I beg to add the details of the analogous formation which I have just had the honour of describing to the Society."

III.

"*The Microscope as a means of Diagnosis.—Singular case of Intestinal Concretions.* By H. Munroe, M.D., Hull.

('Quarterly Journal of Microscopical Science,' No. 18.)

"The value of the microscope as a means of diagnosis is now universally acknowledged by every medical man. Many are the instances I could enumerate, in which, without its assistance, no clear or definite opinion could be arrived at. Among the many cases which have come under my observation, the following one may not be uninteresting, as I know of no other similar case, save one mentioned by our esteemed friend, Mr. Quekett, in his first volume on 'Histology.' I give you the history of the case as detailed to me by Dr. Wilkinson, of Manchester, under whose care the patient was placed, and to whose kindness I am indebted for the account.

"R. L—, æt. 52 years, a power-loom weaver, has never been the subject of any ailment until four years ago; in fact, he does not remember ever having had a day's illness. At that time he suffered slightly from indigestion, felt some uneasiness at the pit of the stomach, with at times, though rarely, actual pain. The food taken frequently returned at intervals, varying from ten minutes to two or even four hours after ingestion. The vomit, if retained for some hours, presented the appearance of buttermilk and treacle. He never vomited except when the stomach contained food; but he was subject to frequent eructations of a small quantity of clear fluid, intensely acid; sufficiently so to set the teeth on edge, and to produce even a shudder at the recollection. About this time he perceived a hard body directly below the ensiform cartilage, but somewhat to the right side, lying as it were between the depending point of the cartilage and the right costal cartilages. He judged that the lump he felt was a hard substance about the size of a hen's egg. He felt this lump pass down along the course of the duodenum and intestines, until it arrived in the left hypochondriac region. A short time after this it was passed by stool, being several weeks after he had first noticed it. The whole of the time he had severe and continued pain; and after it had passed, per rectum, he suffered for thirteen hours severely. Sixteen days afterwards another concretion was passed; and at the end of sixteen days more one still larger. There were no other concretions passed for two years, and then another of a smaller size.

"He then felt a hard tumour in the abdomen on the right of the umbilicus, which has since gradually increased; continuing hard, moveable, and somewhat changes its position, but does not seem to move along the canal.

"The concretions which have been passed have not varied greatly in

appearance, being irregularly oval. The one he presents is hexagonal, apparently presenting articular facets of a lightish brown colour.

"He states that he has lived since childhood principally on oatmeal porridge with treacle, has taken little animal food; and, during the four years he has been unwell, has taken magnesia as a purgative. He, however, says that he took no magnesia before the first concretion was passed.

"Such is the case as sent me by my friend with a portion of the concretion for microscopic analysis. Chemistry and all other means had failed to unravel the mystery of the composition of this concretion. I macerated a portion of it for some time in distilled water, expecting to detect the starch granules of the oat by the polarizing apparatus of the microscope, but in this I failed. I continued the maceration, separating the parts a little with very fine needles, and at last was able to detect very beautifully masses of the hairs of the palea of the oat, of which, and the husks of the oat, the concretion seemed to be entirely made up."

IV.

"*On a Fungus parasitic in the Human Ear.* By JOHN GROVE, Esq., M.R.C.S., &c. Communicated by HENRY DEANE, Esq.

(Read before the Microscopical Society, April 15th, 1857.)

"Having taken a lively interest for some years in the subject of parasitic growths of all kinds, whether occurring on animals or plants, I have lost no opportunity of seeking for them when occasions have presented offering any probability of success to my research.

"In the month of September last (1856) I met with a beautiful specimen of a fungoid growth which was removed from the ear of a gentleman who had been suffering from inflammation of the left external meatus auditorius.

"The ailment commenced with uneasiness and irritation of the ear, diminution of the sense of hearing, and some slight discharge. In a few days there was pain and greater urgency of the other symptoms. As the patient was in the prime of life, of unimpaired constitution, and apparently in vigorous health, I ordered simply poppy fomentations by means of spongio-piline, the ear to be carefully syringed with warm water, and a drop of glycerine to be applied night and morning—the syringing because there appeared to be some flocculent-looking matter deep in the meatus. After a day or two some of this flocculent matter came away in little masses, which was preserved according to order for my inspection.

"The fungi to be presently described being detected, it occurred to me that the best method of preventing their further development would be to use some injection which was likely to be inimical to their existence. Alum was selected, and it seemed to answer perfectly. But soon the other ear began to take on the same symptoms as its fellow, and now the alum injection succeeded in checking altogether the progress of the affection, and the patient was speedily out of my hands.

"The only instance of a growth of this kind in a like situation, that I am acquainted with, is in Robin's work; he quotes, however, from a paper by Mayer, in Müller's 'Archives.' He speaks of a fungoid vegetation which was found in some cysts removed from the ear of a child eight years old, who was suffering with a scrofulous discharge from the external meatus, and had been treated both locally and generally with a variety of medicaments.

"The differences between the description given by Robin and that which I have to offer are such as to lead to the belief that the objects are not similar.

"1st. I detected no cysts, but flocculent membranous-looking masses.

"2d. He describes the stipe as long, and containing within it small granules (or having a granular interior). Now although the accompanying has a rather long stipe, it does not contain spherules or granules.

"3d. The pileus is said by Robin to be small and of a greenish colour, whereas that here shown is comparatively large and of a reddish-brown colour.

"4th. The position and character of the spores are distinctly different. Robin speaks of them as granules, single or double, spread over the surface of the upper swollen extremity of the stipe; but those here exhibited are closely packed oval spores, completely enveloping the upper extremity of the stipe, forming a compact pileus.

"Further, there is a difference in the cases furnishing the growth, the contrast between a scrofulous child, eight years of age, and a healthy man in the prime of life, is as great as could be, and tends to show that the scrofulous habit has no special influence in favouring the growth of the parasite."

INDEX OF VOLUMES I AND II.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

ON

TAPE AND CYSTIC WORMS,

WITH AN INTRODUCTION

ON THE

ORIGIN OF INTESTINAL WORMS.

BY

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TRANSLATED BY

T. H. HUXLEY, F.R.S.,

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VON SIEBOLD

ON

TAPE AND CYSTIC WORMS.

CONTENTS.

AUTHOR'S PREFACE.

INVESTIGATIONS into the natural history of the entozoa, continued for many years, have taught me that it is impossible to obtain a complete view of the different stages of existence through which these parasites pass, if one's observations are restricted to but a few of the localities in which they are found. At an early period of my researches, it became evident that the same entozoon, in its young state, may have a very different habitation from that in which it is found in its adult condition; for these animals undergo the most remarkable metamorphoses, and their habits varying with their changes in form and age, they are necessitated repeatedly to change their residence.

These peculiarities in the natural history of the entozoa, often most difficult of investigation, have rendered the task of the helminthologist, in seeking to obtain a just conception of their genera and species, a very difficult one. It has only too frequently happened that the different stages of development of the same species of entozoa, have been described as so many distinct species or genera; and thus the systematic arrangement of the group has been built upon a faulty foundation. Hence, again, a difficulty has arisen in the way of attaining correct ideas with regard to the modes of propagation of the intestinal worms, and this obstacle could only be removed by determining, in defiance of the authority of the older helminthologists, to give up many genera and species established upon what they supposed to be independent forms.

The investigation of the natural history of the intestinal worms, at the same time, opened up a channel through which their mode of origin could be traced; and indicated a way in which the attacks of those parasites which are dangerous or troublesome to man and animals, could be prevented; an object, in certain cases, of the highest importance, since the morbid changes induced by many entozoa in the organs which they infest, are not always removable.

For a long period, I have been at much pains to inquire into the origin of the entozoa found in man and the domestic animals; and in the present essay I lay before physicians, veterinarians, and breeders, a summary of the results of the observations and experiments which I have made upon the production and development of these creatures. My chief attention has been directed to the destructive cystic-worms, and I believe that the conclusions at which I have arrived are not merely a gain for science, but promise to be of useful practical application.

MÜNICH; *March* 30*th*, 1854.

INTRODUCTION.

CHAPTER I.

UPON THE ORIGIN OF INTESTINAL WORMS.

Having been occupied for many years with inquiries into the natural history of the intestinal worms, a subject involved in much obscurity, I have gradually arrived at the decided conclusion that these parasites do not originate, as has been commonly believed, by "equivocal generation," from substances of a dissimilar nature. With the usual exaggeration and misuse of language, the doctrine of equivocal generation has been applied both to the infusoria and to the intestinal worms. It was difficult, at first sight, to account for the origin and reproduction of these animals, and, even upon closer investigation, they presented many phenomena which could not be recognised in the organization and vital manifestations of other, especially of the higher animals; but instead of seeking for the cause of these exceptional peculiarities, people, accommodating themselves to the usually accepted view as to the natural history of these lower creatures, set the matter straight in their minds, by supposing that the unusual phenomena occurred somehow or other in that way; thus allowing the imagination to indulge in fancies of the wildest description, and even in opposition to the most important laws of nature. It was in this manner that physicians and naturalists thought themselves justified in assuming, that the parasitic worms in the intestines of men and animals owed their origin to ill-digested nutriment, or that they were developed in the most widely different organs from corrupt juices. They took it for granted, that certain

morbid processes in any organ were competent to give rise to parasites, assuming that the elementary constituents of an organ affected by disease, mechanically separated themselves from their natural connection, and not perishing, but transforming themselves into independent organisms, became parasites. Clothed in fine phrases, this idea was everywhere received with favour, and took such deep hold of the public mind, that it is now a matter of no small trouble to eradicate what has, with many, become an article of faith, and to substitute the laws of nature, drawn from experience, for the creation of their fancy. It was certainly more convenient and enticing to give free scope to one's thoughts, and to fill up the frequent gaps left in our knowledge of the origin and multiplication of the lower animals, with pure hypotheses, than as now, renouncing this faulty method of inquiry into nature, to attain, by troublesome researches and careful experiments, a secure insight into her hidden workings.

It was by the latter method that a remarkable and hitherto unanticipated development of the sexual apparatus was discovered in many parasites, such as round-worms, thread-worms, tape-worms, and flukes,[1] in which such an immense mass of eggs and young can be generated, that it seems unnecessary to look further in order to account for their origin. But the precise mode in which the countless brood of these parasites make their way into the interior of the animals they are destined to inhabit, was long but dimly understood, until by degrees attention was directed to certain peculiarities in the mode of life of these creatures, which threw great light upon the subject.

It has been ascertained, in fact, that at particular periods of their existence, the intestinal worms undertake emigrations, and these often very extensive ones, in order to reach that animal whose organs are by nature fitted for their habitation. We now know that the young of the tape-worm, (which inhabits the intestine of the higher animals only,) leave the place where they were brought

[1] With respect to the tape-worms, it is well known that a single individual is often composed of many hundred joints. Each joint is capable of laying many hundred ova, so that the number of the progeny of a single tape-worm is enormous. Professor Eschricht of Copenhagen (see his work 'Das Physische Leben in populären Vorträgen, Berlin, 1852, p. 115) posesses a tape-worm, expelled by a patient of his, which consists of 1000 joints, and some of the joints contain more than 1000 ova. The same writer (ibid., p. 112) having carefully examined the reproductive organs of a female *Ascaris lumbricoides*, estimates the number of eggs in a single thread-worm at many millions.

forth, or laid as eggs (that is to say, they emerge from the intestine of their parent's host), and seek an opportunity to enter into the intestine of some other creature. It is easy to convince oneself of this emigration of the young of the tape-worm, by examining the excrement of animals infested by them, at those times of the year at which they attain their sexual maturity. We then observe, that sometimes single joints, or connected series of joints, full of ova; sometimes immense masses of the ova, are passed with the fæces. The same thing holds good with regard to the ova of the *Distomata* that infest the livers of our ruminating animals; their eggs, after they have been transferred from the liver to the gall-ducts, being washed out with the bile into the intestine, and evacuated with the dung.

These emigrations of the young of the intestinal worms benefit not only the creatures they infest, but themselves. There are many kinds of intestinal worms, in whose eggs the embryo is never hatched if they remain in the place where they have been laid. They must wander to some other place in order to develop their young, or to allow of the escape of the young already developed in them.[1] These young must then either wait for, or seek, an animal to lodge in, having entered into which, they are capable of attaining sexual maturity. By such emigrations the infested animals are at the same time freed from guests, whose increase would be both troublesome and prejudicial. For example, what would happen if the millions of eggs that a single round-worm or tape-worm can produce, were to develop and generate their young in the same intestine in which they were laid? Would not the intestine, after the young had attained their full growth, and brought forth others in their turn, become at last so choked up as to disable this part of the digestive apparatus, so that the whole organism of the unhappy animal must perish, together with his parasites? In any case, the emigration and immigration of the young of the intestinal worms, is a very important though long unregarded part of the history of their propagation; and since

[1] Hence a tape-worm which has found its way into the intestine of an appropriate animal will attain its sexual maturity, but will not, properly speaking, multiply its kind there. For this reason, the tape-worm (*Tænia solium*) infesting the human subject, which is common in Germany, France, [and England,] is commonly called the solitary worm, (Einsiedler-wurm, ver solitaire,) although the name is not a very fit one, as it depends entirely on accident whether only a single individual or a whole society of these worms shall enter the human intestine in the course of their wanderings.

physicians and naturalists have devoted the requisite attention to the subject of these wanderings (to which I directed attention some years back[1]), a number of facts have been discovered, showing more and more that the origin of the intestinal worms in the viscera of animals can be readily accounted for according to natural laws; whereas formerly, hardly anything being really known of the natural history of these parasites, their mode of origin and propagation, already difficult enough of comprehension, was rendered more and more mysterious by an hypothesis of "equivocal generation" entirely devoid of any direct support.

An important circumstance, very favorable to the progeny of the intestinal worms during their wanderings, is the solidity of the egg-shell in which they are commonly contained. By its hardness and resistance, the egg-shell of many kinds of intestinal worms efficiently protects the enclosed germ and yelk, or the already developed embryo, against injury from without, and maintains within the ovum the degree of moisture requisite for the further development of the young. In this way the ova preserve their vitality for months together, notwithstanding the many vicissitudes to which they are exposed after leaving the dwelling of their parents. They pass into dust-heaps, privies, drains, &c., where, surrounded sometimes by a greater, sometimes by a lesser degree of moisture, they are subjected to various degrees of temperature, until, deposited in the dung-heaps into which corrupt and mouldering organic substances are usually converted, they are, as manure, spread upon the fields and meadows, where, under favorable influences of the weather, particularly if supplied with adequate moisture, they become further developed. It will be obvious that the young of the intestinal worms have not far to seek for an opportunity of re-entering other animals, when we consider that they are scattered through the manured soil amongst the seeds that have been sown there; that these produce plants which generally serve for the support of men and animals, and that the young worms adhering to them may thus be easily swallowed. Again, it may well happen that showers of rain occasionally wash out the ova of the intestinal worms from the dung-heaps or manured soil, carrying them off into streams and brooks, and

[1] See my article "Parasiten" in R. Wagner's 'Handwörterbuch der Physiologie,' Bd. ii, 1844, p. 645.

so affording another mode of entrance into men and animals, by the water which the latter drink.

Many of the young intestinal worms, more or less developed, but still enclosed in the egg-shell, remain quite inactive in their wanderings, and for these passive emigrants it is, of course, a mere matter of chance whether they reach their goal or not. The young of others, having previously left their egg-shell, may take an active share in the process, creeping up out of their holes and corners in wet weather, or in the damp mornings, upon the slippery plants, and so entering the animals fitted for their habitation, when they come to seek for food.

According to an old-standing custom which careful shepherds strictly keep up, sheep are never allowed to be driven out in the morning till all the dew is off the grass, nor yet to graze in damp swampy pastures. By this precaution the shepherds unwittingly protect their charges from the attacks of *Strongyli* and *Distomata.* It is on like grounds that seasons of wet weather are so frequently fatal to flocks, it being then easier for the young intestinal worms to enter the sheep and give rise to entozoic pestilence; whilst in continuously dry and hot seasons a great number of these young worms must be dried up and destroyed, and thus the sheep are delivered from their attack and all its evil consequences.

But in thus expressing my opposition to the various hypotheses of the origin and multiplication of the parasitic worms, it might appear as if I had fallen into the very error I condemn, and the objection might be raised that the explanation I have just given of the singularities observed in the mode of occurrence of the intestinal worms is, like former hypotheses, merely imaginary, and that I am unable to support it by demonstrative experimental evidence.

This I must beg leave to deny. It is true that what I have said respecting the origin of the *Strongylus filaria* and of the fluke (*Distomum hepaticum*) in sheep, is as yet only an assumption, and not to be regarded as directly proven. Nevertheless, my assumption rests upon the analogy of reliable facts, which I have established by observation in other intestinal worms. The recognition of definite, though at first isolated truths, has often done much for science, since by careful application of the laws of analogy they have furnished the key to phenomena long hidden in obscurity.

In order to show that emigration and immigration are regular

phases in the life of many intestinal worms, I will here recall certain observations of my own on the natural history of the following parasites.

For a long time the origin of the thread-worm, known as *Filaria Insectorum*, that lives in the cavity of the bodies of adult and larval insects could not be accounted for. Shut up within the abdominal cavity of caterpillars, grasshoppers, beetles, and other insects, these parasites were supposed to originate by equivocal generation, under the influence of wet weather or from decayed food. Helminthologists were obliged to content themselves with this explanation, since they were unable to find a better. Those who dissected these thread-worms and submitted them to a careful inspection, could not deny the probability of the view that they arose by equivocal generation, since it was clear that they contained no trace of sexual organs. But on directing my attention to these entozoa, I became aware of the fact that they were not true *Filariæ* at all, but belonged to a peculiar family of thread-worms, embracing the genera *Gordius* and *Mermis*. Furthermore, I convinced myself that these parasites wander away when full grown, boring their way from within through any soft place in the body of their host, and creeping out through the opening. How many a butterfly-collector, keeping caterpillars for the breeding of fine specimens of butterflies, must have seen one or more yellowish white thread-worms winding their way out of them! These parasites do not emigrate because they are uneasy, or because the caterpillar is sickly, but from that same internal necessity which constrains the horse-fly to leave the stomach and intestine of the horse where he has been reared, or which moves the larva of the gad-fly to work its way out of the boils on the skin of oxen. The larvæ of both these insects creep forth in order to become chrysalises and thence to proceed to their higher and sexual condition. This desire to emigrate is implanted in very many parasitic insect larvæ, and has long been a well-known fact in entomology. Now I have demonstrated, that the perfect, full-grown, but sexless thread-worms of insects are, in like manner, moved by this desire to wander out of their previous homes in order to enter upon a new period in their lives which ends in the development of their sexual organs. It is true that in the boxes and other receptacles, in which one is generally accustomed to keep caterpillars, these creatures perish; they roll themselves together, and from the absence of

the necessary moisture, they in a short time dry up. But their fate is very different when the infested insects remain under natural conditions; the thread-worms, as they leave the bodies of their hosts, then fall to the ground, and crawl away into the deeper and moister parts of the soil. Thread-worms found in the damp earth, in digging up garden-beds and cutting ditches in the fields, have often been brought to me, which presented no external distinctions from the thread-worms of insects externally. This suggested to me that the wandering thread-worms of insects might be instinctively necessitated to bury themselves in damp ground, and I therefore instituted a series of experiments with such entozoa (which I procured in numbers from the caterpillars of a moth, *Yponomeuta evonymella*), by placing the newly emigrated worms in flower-pots filled with damp earth.[1] To my delight, I soon perceived that these worms[2] began to bore with their heads into the earth, and by degrees drew themselves entirely in. For many months (through the whole winter) I kept the earth in the flower-pots moderately moist, and on examining the worms from time to time I found, to my great astonishment, that the sexual apparatus became gradually developed in them, and that, after a time, eggs were formed and were eventually deposited by hundreds in the earth. Towards the conclusion of winter I could succeed in detecting the commencing development of the embryo in these eggs. By the end of spring they were fully formed, and many of them, having by this time left their shells, were to be seen creeping about the earth in the flower-pots, which I still carefully kept damp. I now conjectured that these young worms would be impelled by their instincts to pursue a parasitic existence and to seek out an animal to inhabit and grow to maturity in, and it seemed not improbable that the brood I had reared would, like their parents, thrive best in the caterpillar. In order, therefore, to induce my young brood to immigrate, I procured a number of very small caterpillars of *Yponomeuta*, of half a line in length, which the first spring sunshine had just called into life. For the purpose of my experiment I filled a watch-glass with damp earth, taking it from amongst the flower-pots where the thread-worms had wintered, and of course satisfying myself that it con-

[1] These experiments and their results have been already published in the 'Entomologische Zeitung,' 1848, p. 290.

[2] I have named this species of thread-worm *Mermis albicans*.

tained a number of lively young of the *Mermis albicans*. Upon this I placed several of the young caterpillars of the *Yponomeuta* in order that the worms might gratify their immigrative propensities. I must explicitly remark, that before experimenting with the caterpillars, I carefully examined each with the microscope, in order to ascertain whether it was not already inhabited by young thread-worms. From their softness and transparency, I could ascertain this point with certainty, without in the least injuring them. The event proved that this inspection was necessary, for out of twenty-five individuals which I at first selected, three contained a thread-worm embryo, which was excessively like those in the flower-pots. I published the results of these experiments a year or two back, in an essay upon the thread-worms of insects[1], from which I quote the following :

"From amongst those caterpillars which microscopic inspection clearly demonstrated to be free from thread-worms, thirteen were placed in a watch-glass filled with damp earth containing many lively *Mermis*-embryos. After eighteen hours I was able to discover *Mermis*-embryos in five of the caterpillars. On a second occasion, three-and-thirty of the caterpillars of *Yponomeuta cognatella*, likewise carefully examined and found free from parasites, were in the same way placed in a watch-glass filled with damp earth containing *Mermis*-embryos. After four-and-twenty hours, fourteen contained *Mermis*-embryos. Six of these little caterpillars each contained two small worms, whilst in two others there were as many as three worms. I also employed other caterpillars (of three lines in length) of *Pontia Crataegi*, *Liparis chrysorrhœa*, and *Gastropacha Neustria*, which I took out of coccoons where they had passed the winter. They were, in like manner, placed in a watch-glass upon moist earth containing *Mermis*-embryos. On the next day, among fourteen caterpillars thus treated, I found ten infested with *Mermis*-embryos ; five of these contained two worms each, and into one even three worms had wandered." It was clear that these young thread-worms had bored their way through the soft skin into the interior of the young caterpillars.

From the results of the experiments I have just recorded, one must conclude that it is not necessary to turn to the mystical doctrine of equivocal generation for an explanation

[1] See 'Entomologische Zeitung,' 1850, p. 239.

of the presence of worms in insects, since here the origin of the parasites is sufficiently obvious. Those who cannot make up their minds to renounce the easy and convenient doctrine of equivocal generation, may perhaps object, that the history I have given of the propagation of the *Mermis albicans* stands alone, and only makes an exception from the rule. To this I answer, in the words of Goethe: "Nature goes her way, and that which appears to us as the exception, is the rule." That this is really the case in the present instance, is proved by recent investigations into the natural history of the intestinal worms. Since attention has been directed to their wanderings, more and more facts have been daily brought to light, all tending to show that the emigration and immigration of these parasites is a much commoner and more widely extended occurrence than was at first imagined. Habits, very similar to those which I have just described in *Mermis albicans,* are also to be observed in another thread-worm, the well-known *Gordius aquaticus,* which has also been shown to live parasitically in the cavities of the bodies of various insects, viz.: grasshoppers, terrestrial and aquatic beetles, and in their larvæ; and to grow from a most diminutive worm to one of several inches in length, which then makes its way out, to attain to sexual maturity elsewhere, often in the water. These facts were formerly wholly unknown, though it must have long appeared surprising that this thread-worm, which, on account of its form and colour has been compared to a horse-hair, is, whenever met with in the water, of its full size. But now that we know that the *Gordius aquaticus,* like the *Mermis albicans,* enters in the embryo state into insects, growing with them, and only quitting them when it has done growing, the striking phenomenon I have mentioned is easily accounted for.

Just as, for the reasons already named, some kinds of parasites that have emigrated are never met with below a certain size; so, some kinds of parasites that have already made their way into the interior of animals are not to be found under a certain size, however often and carefully they may be sought for, a circumstance which must certainly have been noticed by many physicians and naturalists, without their having paid further attention to it. It is now known that many parasites do not enter into the animals in which they are to pass through their further stages of growth until they have attained a

certain degree of development elsewhere. This is particularly the case with such intestinal worms as remain parasitic in the last stage of their existence, viz.—that of sexual maturity, whilst the *Gordiacæi* (*Gordius* and *Mermis*), as soon as they are full-grown, quit their parasitical life, in order to become sexually mature, away from the animal they have infested. During these early wanderings, the worms in question commonly undergo a change of form—a sort of metamorphosis, often accompanied by other phenomena of so highly remarkable and abnormal a character, that naturalists could not at first understand the varied character and import of these phases of existence, nor comprehend their relation with hitherto known facts.[1] For a long time it was supposed that these discoveries were isolated facts, and they were regarded as a sort of curiosity; but here again the saying was verified, that that which at first appeared to be the exception, eventually proves to be the rule. By degrees, a mass of observations upon certain remarkable metamorphoses of the intestinal worms accumulated, and constituted a complete chaos of seemingly irregular phenomena, which broke down every barrier hitherto set by the acknowledged laws of animal existence and propagation, until the penetration of the Danish naturalist, Steenstrup,[2] succeeded in evolving a certain order out of this confusion, by the discovery therein of a hidden, underlying law of nature, by which all the phenomena that had seemed so devoid of plan could be reduced to order. Steenstrup named the newly discovered law, the "Alternation of Generations," a phrase which describes this phenomenon. "That an animal bears young which

[1] I may refer to the "king's-yellow" worms discovered by Bojanus in water-snails, and now become famous. (See Oken's 'Isis,' 1818, p. 729, plate 9, figs. A, F.) Of this discovery Oken says "Observations of this kind make one dizzy." No less attention was excited by Von Bär's description of the *Bucephalus polymorphus* of the fresh-water mussel. (See 'Verhandlungen der Kaiserl. Akad. d. Naturforscher,' B. xiii, 1826, p. 570, pl. 30); and by the *Leucochloridum paradoxum*, first discovered by Ahrens, and afterwards described anew by Carus. (See 'Magazin der Naturforschenden Freunde zu Berlin, 1810, p. 292, pl. 10, figs. 12—19, and the 'Verhandlungen der Kaiserlichen Akademie,' Bd. xvii, 1855, p. 87, pl. 7.)

[2] See his important essay on the 'Alternation of Generations,' Copenhagen, 1842. [This essay has been translated by Mr. Busk, and forms one of the publications of the Ray Society. It must not be forgotten that the first conception of the doctrine of the "Alternation of Generations," and the first use of the term, are due to Chamisso. See his 'De Animalibus quibusdam e classe vermium Linnæana,' 1819, and 'Reise um die Erde.'—Ed.]

are, and remain, dissimilar to their parent, but bring forth a new generation, whose members either themselves, or in their descendants, return to the original form of the parent animal."

Any one who has not familiarized himself with the fundamental idea of this doctrine of the alternation of generations, may easily imagine it to be nothing but a modification of the long well-known metamorphosis, exemplified by the tadpoles of frogs and toads, or by the larvæ and chrysalises of most insects. This is, however, by no means the case. Those reptiles and insects that are subject to metamorphosis, no doubt bring forth young that differ from the parent, but there are two respects in which the act of simple metamorphosis widely differs from the highly complex alternation of generations.

Although Steenstrup has already particularly noticed these two grounds of difference in his definition of the alternation of generations, I deem it not altogether superfluous on my part once more to draw especial attention to these important divergences, if only for the benefit of those who are unfamiliar with the phenomena. The first point of difference between the alternation of generations, and metamorphosis, is, that the young of those animals whose mode of development comes under the former head, are not only unlike their parent at first, but remain so: the second distinction rests on the important fact that this young generation, so dissimilar to the parent animal, brings forth new creatures, which either themselves, or in their descendants, revert to the original form of the first parent. Whereas, on the other hand, in simple metamorphosis, the dissimilar young pass by gradual changes into the likeness of the parent animal, and until this metamorphosis is complete, are incapable of generation. Steenstrup has given the name of "nurse" to those young, which, whilst departing from the parent type, remain, and propagate under their own form.

It thus happens that in the alternation of generations (to use the words of Steenstrup), the parent animal produces "nurses," whose descendants only, take her form. A most important circumstance which characterises these nurses or "Agamozooids"[1]

[1] I have rendered the word "keim-körper" by "sporula," meaning thereby a free germ which is capable of development without fecundation, just as is the spore of a cryptogamous plant. When the sporulæ are developed in a special organ I term this organ (the "keimstock" of Von Siebold) the "sporularium." Any independent form from which sporulæ or their equivalents alone are developed (the "ammen" or "nurses" of Von Siebold, Steenstrup, &c.) I term "agamozooids." See concluding note.—[Ed.]

physiologically, is, that they bring forth young, without themselves possessing any real sexual apparatus. These Agamozooids, in fact, multiply by division, by external or internal gemmation; they develop within their bodies germs which become fresh creatures. But these germs do not deserve the title of "eggs;" nor is the place where they are developed to be called an "ovarium," since the germs, which I shall for the future distinguish by the name of "sporulæ," are not only devoid of the ordinary constituents of an ovum, as vitelline membrane, yolk, germinal vesicle, and so called germinal spot, but the further development of the germ-body is not preceded by those conditions, (I mean that "impregnation" by means of a special seminal matter produced in a testis,) which is essential to the development of true ova developed within an ovarium. The organ in which, in certain Agamozooids the "gemmæ" are formed, cannot therefore be properly termed an "ovarium," and I shall distinguish it by the name of "sporularium." No "nurses" present any sexual distinctions, and hence their method of multiplication and propagation, which takes place by means of sporulæ formed within sporularia, or by ordinary budding, or by division, must be arranged amidst the modes of asexual reproduction.

Very many cases of the alternation of generations occur among the *Trematoda.* The relations that the various changing forms of these animals have to one another, remained long unsuspected, since it was not an easy matter to discover among the various successively alternating generations of a single fluke-worm, the clue to their origin from one and the same parent. The recognition of the connection of these forms, was rendered more difficult of discovery by the fact, that these alternating generations of animals not only changed their appearance, but also their dwellings, whereby their parentage was still further concealed. These multitudinous difficulties in the way of the observers of the alternation of generations, render it impossible for me to give a complete account of all the complex series of changes undergone by any single Trematode in the course of its development. Up to this time only longer or shorter fragments of the circle of vital phenomena, broken as they are into many phases by the alternation of generations, have been made out in a few *Trematoda.*

However, these fragments do not relate to one and the same period in the life of these parasites, nor to the same generations

of Agamozooids, but to the most widely various periods and stages of their development. We can, therefore, by careful selection and judicious arrangement of these observations, build up a general view of the complicated process of the alternation of generations in the *Trematoda* in general.

The so-called *Cercariæ* offer the best exemplification of the alternation of generations as it occurs in the *Trematoda*. These *Cercariæ*, which swim about with great activity by means of a cylindrical tail, have long been known; but until the discovery of their real origin and signification, were taken, on account of their diminutiveness, for *Infusoria*. When, at a recent period, their parasitic nature was recognised, it became a matter of much astonishment that the *Cercariæ* were not derived from parents resembling themselves, but that they originated in peculiar animated, worm-shaped sacs, which were found buried amidst the sexual and digestive organs, in various kinds of fresh-water snails and mussels. The form of the sacs that produce the *Cercariæ* is, notwithstanding the simplicity of their organization, very various; in accordance with the form and kind of *Cercaria* to be developed within them. Some kinds of *Cercaria*-sacs have an oral aperture, and a simple blind intestine, but in others this digestive apparatus is entirely wanting. One series of *Cercaria*-sacs possesses contractile walls, whilst others again are stiff and inflexible. In one particular group, the *Cercaria*-sacs are simple shut receptacles; in another, the sacs ramify and anastomose to a great extent. The whole of these multifariously-shaped *Cercaria*-sacs enclose within the walls of their bodies a cavity which, besides the intestinal

Fig. 1. Fig. 2. Fig. 3.

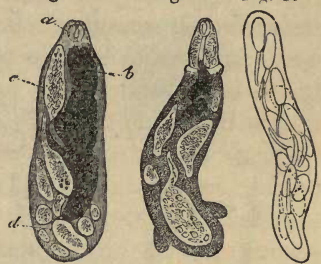
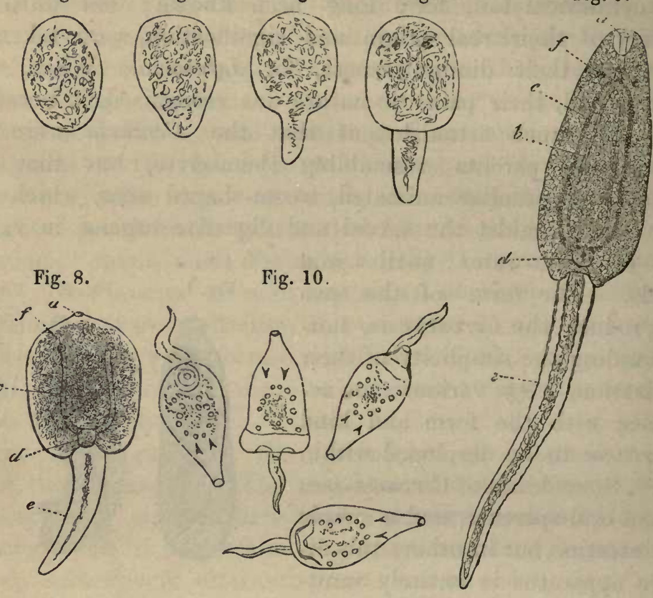


Fig. 1. A cercaria-sac (two lines long) provided with an elongated alimentary canal —the agamozoöid of *Cercaria ephemera*. *a*. Oral cavity. *b*. Alimentary canal. *c*. A developed *Cercaria ephemera*. *d*. Sporulæ not yet developed into *Cercariæ*. These sacs are found in *Planorbis corneus*. Fig. 2. A cercaria-sac—the agamozoöid of *Cercaria armata*— provided with a very short alimentary canal and remarkable for the two short lateral abdominal processes, found in *Lymnæus stagnalis*. Fig. 3. A perfectly simple cylindrical cercaria-sac, having no digestive canal. I found it as the agamozoöid of *Cercaria sagittifera* in *Helix pomatia*.

cæcum, (where such a structure exists,) contains nothing but young *Cercariæ*. These young are developed, not from ova, but from gemmæ, which differ essentially from ova. They are solid, round, and somewhat flattened discs, which, growing and developing, become little caudate worms, resembling in form and organization certain *Trematoda* (*Distomum, Monostomum, Diplodiscus, Gastrostomum*).[1]

Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10.



Figs. 4—10. The various stages of development of *Cercaria ephemera*, from the agamozoöid, fig. 1. Fig. 4. Sporula. Fig. 5. Sporula thinned at the hinder end. Fig. 6. Sporula with this taper posterior extremity elongated into a tail. Fig. 7. The sporula in this stage has assumed the form of a *Cercaria*. The tail is already defined. Two black pigment-spots appear on the fore part of the dorsal surface. Fig. 8. A still further developed *Cercaria*. *a*. The oral aperture. *c*, *d*. The urinary organ. *e*. The Tail. *f*. Two pigment-spots. Fig. 9. A fully formed *C. ephemera* (one millimetre long). *a*. Oral cavity. *b*. Alimentary canal. *c*, *d*. Urinary organ filled with granular urine. *e*. Tail. *f*. Three black spots on the anterior part of the dorsal surface. The median pigment only begins to be developed in the last stage of development. The whole figure of the body of *Cercaria ephemera* corresponds with that of *Monostomum*. Fig. 10. Four cercariæ, after Filippi, from *Planorbis nitidus*, whose posterior sucking apparatus (composed of two suckers, one enclosed within the other) is seen in different stages of contraction and expansion. When the tail is cast off these *Cercariæ* are altogether similar to *Diplodiscus*.

[1] The *Cercariæ* and the sacs have been so often referred to of late that I may leave

It was a long while after the origin of the *Cercariæ* was known, before any explanation offered itself as to how the parasitic *Cercaria*-sacs in water-snails and mussels arose, and as to what became of the *Cercariæ,* which, when fully formed, always seemed to desire to leave the bodies of the dissimilar parents in which they had been developed; penetrating the walls of their sacs, and boring through the substance of the bodies of the snails and mussels into the water, where they at first creep, and at length paddle swiftly about by the help of their tails.

With regard to the origin of the *Cercaria*-sacs, it cannot be supposed that they proceed from *Cercariæ,* since, in these last, no organs of propagation are perceptible. In this perplexity the doctrine of equivocal generation was again invoked, and it was assumed that certain glandular cæca of the digestive or sexual apparatus, in the snails and mussels in which *Cercaria*-sacs are found, were converted into such sacs, and produced *Cercariæ* by equivocal generation. This was, of course, a mere assumption based upon no direct observation.

Now I was so fortunate as to make a discovery by which much light has been thrown upon the obscure history of these *Cercariæ* and *Cercaria*-sacs.

It was in the year 1833, whilst fulfilling my duties as district medical officer (kreisphysicus) at Heilsberg, in East Prussia, that I had occasion to examine a large number of specimens of those *Trematoda* known to Helminthologists by the name of *Monostomum mutabile,* which were very commonly found in the geese of that locality, in the cavities which lie underneath the eyeballs. I convinced myself that these para-

Fig. 11. Fig. 12.

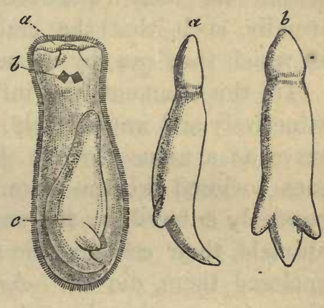


Fig. 11. An infusoroid embryo of *Monostomum mutabile* which has just left the egg. (See my essay on this subject in Wiegmann's 'Archiv.,' 1835, i, p. 69.) *a.* Sucker. *b.* Double pigment-spot. *c.* Sporule-cyst.—Fig. 12. *a.* The sporule cyst left free by the death of the infusoroid embryo. *b.* The same viewed laterally. This body closely resembles the sporule cysts of *Cercaria armata.*

their manifold forms undescribed in this place, merely referring to the descriptions and figures which Von Bär, in his masterly 'Beiträge zur Keuntniss der niederen Thiere' ('Nova Acta,' vol. xiii, pars 2a, 1826,) and Steenstrup, in his 'Alternation of Generations,' have given.

sites, belonging to the order *Trematoda,* bring forth living young, which assume the form of *Infusoria,* and swim about in the water by means of the cilia which cover the whole surface of their bodies. After some time, I observed that these embryos apparently died, their bodies seeming to break up and gradually disappearing, but always leaving behind a sharply defined, mobile, cylindrical body, provided with two short, lateral processes. In all the embryos, without exception, this body was visible through their parietes while they still lived. To my great astonishment, upon further observation of these contractile remains of the *Monostomum* embryos, I discovered that they agreed precisely in form, structure, and movement with certain young *Cercaria*-sacs. Hence I ventured to conclude that the *Cercaria*-sacs proceed from *Trematoda.* At the same time, these observations seemed to indicate how it was possible for the inert, helpless *Cercaria*-sacs to make their way into snails and mussels. The *Monostomum mutabile* is known to reside in such cavities of the body of wading and swimming birds, as possess natural external apertures; when, therefore, the embryos of a *Monostomum mutabile* are born, they will issue without much difficulty from the animal infested by their parents, each carrying its *Cercaria*-sac within its body: and the habits of the infested animals are usually such that the embryos will at once pass into water, in which they can, by means of their cilia, swim swiftly about.

In this element, the infusory *Monostomum* embryos will, instinctively and immediately, seek out those animals that are fit to serve as a nidus for the further development of the *Cercaria*-sacs enclosed within them. After the *Cercaria*-sacs have thus passively entered, by the natural apertures, into their appropriate animals, their carriers, the ciliated embryos which have hitherto enclosed them, die off. As a sort of animated covering to the *Cercaria*-sacs, they have performed their office; and it is now left to the young that have just been released, to work themselves deeper into their new habitation by their own efforts, and to seek out those places which will afford them the necessary nourishment for further growth, and for the development of their brood of *Cercariæ.*

I have not yet been able absolutely to witness this process of immigration of *Monostomum* embryos containing *Cercaria*-sacs, and as I have filled up the gaps in observation with my own ideas on the subject, what really occurs may be somewhat

different; still, the immigration of the *Monostomum* embryo, which is the principal point, must take place, since the singular relations of the infusorial *Monostomum* embryos and the young *Cercaria*-sacs they contain, point distinctly to this conclusion.

Every one will understand, that the knowledge of even such a small fragment of the history of the development of the *Monostomum mutabile* as this, was of the utmost value, since it afforded the key to the long inexplicable mode of origin of the *Cercaria*-sacs. There now only remained the question as to what became of the *Cercariæ,* and in what relation they stood to the *Trematoda.* It was an old idea that there was great similarity between the bodies of the *Cercariæ* and certain *Trematoda,* viz., *Monostomata* and *Distomata,* and the force of the comparison was strengthened by the fact that the *Cercariæ* cast off their tails after leaving the sacs, and thus become still less different from these *Trematoda.* Many *Distomata* whose bodies are encircled with spines at their anterior extremity, for example, *Distomum trigonocephalum, echinatum, uncinatum,* and *militare,* are so like certain *Cercariæ,* that when the latter have thrown off their tails, any unprejudiced person would take them for the young of these *Distomata.* In fact, in their whole organization, the *Cercariæ* are really no other than young *Trematoda.* The circumstance that one never finds sexual organs in the *Cercariæ* is strongly corroborative of the notion that they are young *Trematoda* not yet sexually developed. Here again we have to do with parasites destined to emigrate and immigrate, that in some other situation they may arrive at sexual maturity. The course which the *Cercariæ* take in their wanderings is, however, a much longer and more complicated one, than that followed by the sexless *Gordiacei.* These need only leave the insects they have hitherto infested and withdraw into damp ground, where fully grown as they are, and provided with the necessary store of fat in their bodies, they can quietly await the development of their sexual organs. On the other hand, the emigrating *Cercariæ* are destined to enter vertebrate animals, since it is only in the intestinal canal of certain mammals, birds, reptiles, or fishes, that they can grow and mature their sexual organs.

Many of my readers may be unable to conceive how it is possible for *Cercariæ* living in water, to enter into the intestines of such mammals and birds as live far away from water, or, at any rate, never come into proximity with the

waters in which the *Cercariæ* live. I can, however, offer a solution of this apparent mystery, having surprised many *Cercariæ* in the act of migrating. Before I say anything more about this, I must mention a peculiarity which is to be noticed in most of the *Cercariæ* after they have left their sacs. This is their habit of encysting themselves, a process which is effected in the following manner. After a *Cercaria* has been for some time in the water, first creeping and then swimming about with manifest restlessness, it gathers itself up into a ball, and emits from its whole surface a mucous secretion which soon hardens, and since inside of this mucous mass the worm, coiled up into a little ball, turns round without stopping, invests it as it were in an egg-shell. During this process of encysting the *Cercaria* invariably casts off its tail, so that the capsule eventually encloses the body merely. (fig. 13). For a long time I vainly wondered what could be the object of this process, and, never understood what its signification in Cercarian life was, until, in dissecting some insects, I met with a fact which suggested how I might gain the knowledge I sought for. In the larvæ of a great number of various kinds of aquatic insects, of *Libellulidæ*, *Ephemeridæ*, *Perlidæ*, *Phryganidæ*, I found encysted *Cercariæ*, which I again discovered in the same animals, after they had left the water, and had been transformed into winged insects. Not one of these encysted *Cercariæ* lodged in an insect, was either full-grown or possessed sexual organs. I only observed one other slight step towards their further development; the sexual apparatus, viz., the testis, the germarium, and the copulatory organs, were already faintly indicated. As, however, perfectly full-grown and sexually developed *Trematoda* are never met with in insects, I decided, after the discovery of the encysted *Cercariæ* in them, that they merely sought out the insects as a temporary resting place.

Fig. 13.

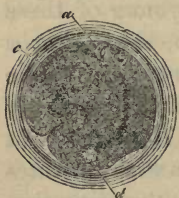


Fig. 14.

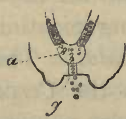


Fig. 13. Encysted *Cercaria ephemera*. *a*. Sucker. *c, d*. Urinary organ.—Fig. 14. Abdominal extremity of a *Cercaria ephemera*, in which, by the casting of the tail the urinary organ has been opened externally. *a*. Inferior expanded end of the urinary organ. *g*. Aperture out of which the granular urine is excreted. Before I pointed out the true import of this urinary organ these granules were regarded as eggs, and when the urine was excreted they were thought to be laid.

Most of the sexually developed *Trematoda* are parasitic upon the higher *Vertebrata,* the *Cercariæ* being, in fact, nothing else than young sexless *Trematoda,* whose instinct it is, to pass out from the inferior animals where they are produced, into the higher forms in which they attain the power of sexual reproduction. Should those *Cercariæ* which are generated in aquatic molluscs, be able to attain their sexual maturity in the intestines of insectivorous birds or mammals alone, they can only reach the latter locality by entering the larvæ of aquatic insects, and then becoming encysted in the manner already described. In this condition they remain, until the new animal in which they have established themselves, having undergone its metamorphosis, leaves the water and is swallowed by some insectivorous vertebrate.

In the act of digestion the body of the insect is destroyed, together with the capsule of the imprisoned *Cercaria,* which in this manner finds itself transplanted into those new circumstances which are alone fitted to permit of its further change into a sexual Trematode.

That this instinctive impulse of the *Cercariæ* to encyst themselves after emigration, is accompanied by a desire to pass into insect larvæ, I assured myself by ocular demonstration. I had procured a large number of specimens of *Cercaria armata* which had emigrated from the common *Lymnæus stagnalis,* and put them into a watch-glass filled with water, in company with several live Neuropterous larvæ (of the families of the *Ephemeridæ* and *Perlidæ*). I soon observed, with the microscope, that the *Cercariæ,* which at first, flapping their tails, moved freely about in the water, at last betook themselves to the insect larvæ, and crept restlessly about them. It was easy to see from their movements that the little worms had some object in view. The *Cercaria armata,* as is well known, is provided with a spine-like weapon, pointing

Fig. 15.

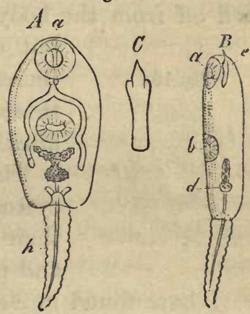


Fig. 15. *A.* A *Cercaria armata* viewed from the abdominal surface. *a.* Oral sucker with the frontal spine showing through it. *b.* Ventral sucker. *c.* Digestive apparatus. *d.* Urinary organ. *h.* Tail whose root plugs up a pit in the hinder end of the body, in which the urinary organ opens.—*B.* The same *Cercaria* viewed laterally *a, b, d,* have the same signification.—*e.* The frontal spine. The alimentary canal is left out in this view.—*C.* The frontal spine of this *Cercaria* very much magnified, and viewed from above.

forward from the centre of the animal's head. (Fig. 15 *B.*) I could readily perceive, that these *Cercariæ* which I was observing, frequently paused in their inspection of the insects, and inserted this weapon into their bodies as they crept over them. This probing experiment, for it was clearly nothing else, was repeated again and again, until the larva had discovered one of the soft places between the segments of the insect's body; this being reached, it never moved from the spot, but worked incessantly with its spine, until a way was bored through the soft place it had fastened on. Scarcely was the point of the spine fairly through, ere the supple worm inserted his thin anterior extremity into the wound, widened the opening a little, and by degrees drew in his whole body, which became wonderfully slender under the operation. The tail of the *Cercaria* was not drawn inside the insect, but remained hanging outside the puncture, being doubtlessly seized and nipped off, by the sudden closing of the wound when the body of the *Cercaria* had slipped through. Having selected very young and delicate Neuropterous larvæ for my inquiry, the transparency of their bodies enabled me to continue to observe the tail-less *Cercariæ* after their entrance; they forthwith lay still, drew themselves up into balls, and surrounded themselves with a cyst. During the process of encysting, the frontal spine fell off from the body of the *Cercaria,* and lay apart by its side, but enclosed within the cyst.[1] This weapon, therefore, undergoes the same fate as the tail of these animals, each apparatus being cast aside after fulfilling its intended end.

Fig. 16.

The impulse to immigrate and become encysted is so strong in all the *Cercariæ,* that their efforts appear to be occasionally over hasty, and perhaps lead them altogether astray.

I have found in *Aselli* and *Gammari,* encysted *Cercariæ,* which in every way resembled those which had passed into insects.

Fig. 16. An encysted *Cercaria armata.* *a.* Oral sucker. *b.* Ventral sucker. *c.* Digestive canal which is connected with the oral sucker. *d.* Urinary organ filled with granular urine. *e.* Cast off frontal spine which now lies free in the cavity of the cyst. *f.* Aperture of the urinary organ, which becomes visible after the tail is cast off. *g.* Cyst in which the tailless *Cercaria* remains encysted as an asexual *Distomum.*

[1] The observation above detailed (which I have already published in Wagner's 'Handwörterbuch,' Bd. ii, p. 669,) can be easily repeated, since the sacs of *Cercaria armata* are excessively common in our fresh-water snails.

Now, if these *Cercariæ* can only attain their sexual maturity in the warm-blooded vertebrate animals, which devour insects, and therefore seek their food in the air or on land alone, the *Cercariæ*, that had established themselves in the *Aselli* and *Gammari*, would wait in vain for the time to arrive when they should be transported into the air, since the animals in which they were domiciled would never quit the water. Again, many *Cercariæ*, in their haste, become encysted incautiously at so early a period, that the purpose of the process is defeated.

I have already shown that the emigrated *Cercaria ephemera* attaches itself to water-plants, or any other objects in the water, by means of the cyst which it elaborates; other *Cercariæ* even become encysted before they quit the body of the aquatic snail in which they were generated; whilst some, again, have even been found encysted within the *Cercaria*-sacs.[1] Steenstrup takes this to be a normal phenomenon; I should only consider it such, provided that the encysted *Cercariæ* in the snails are intended to attain their sexual maturity, in the intestines of fishes or of water-birds feeding on snails.

Although the various facts I have communicated can only be regarded as fragments of the natural history of certain *Trematoda*, they are yet capable of being connected into a whole, if the theory of the Alternation of Generations be extended to them. For instance, from the foregoing statements, we perceive that certain sexually matured Trematoda (*Monostomum, Distomum*) generate young within their sexual organs, which are not developed into sexual individuals similar to their parents in form and structure; but that, on the contrary, each embryo is converted into an animal of remarkably different form, viz., into a *Cercaria*-sac, which has the import of a sexless nurse, since without possessing sexual organs, it nevertheless generates young *Cercariæ*. These *Cercariæ* again differ from their parents, but gradually become sexually perfect, and in form and structure take the likeness of their grandparents. The several embryos of these *Trematoda*, therefore, do not pass into an equal number of new and separate sexual *Trematoda*, but each embryo produces a nurse, which, by asexual generation, brings forth a greater or less number of sexual *Trematoda*.

[1] Steenstrup (l. c., p. 85, pl. iii [English translation]), has more particularly described and figured such *Cercaria*-sacs containing encysted *Cercariæ*.

If we follow those *Trematoda* which are subject to the Alternation of Generations, in their wanderings, we shall see that they are likely to meet with many obstacles to the completion of their developmental course, which is the entering into the viscera of an animal in which they can become sexually developed. It may happen that the various emigrations and immigrations of the infusorial embryo, or of the tailed *Cercariæ*, may miscarry; or it may be, that the exact time for the *Cercaria* to become encysted may be missed; or that after the due occurrence of the encysting process, the insect selected for its penultimate habitation may die at an inappropriate time or place, and so prevent the encysted *Cercaria* from reaching the last animal, or that one fitted for its final residence. This destruction of the various forms of *Trematoda* by untoward circumstances is compensated by the fact, that they are furnished by the Alternation of Generations with the means of greatly multiplying the various developmental stages of their descendants. By these means the propagation of these animals is secured, since, notwithstanding the mishaps by which many are arrested or destroyed, a sufficient number of individuals always remains out of the numerous young of the nurses and larvæ, who, in spite of all obstacles, achieve the end in view—the propagation of their species.

The history of the *Cercariæ* enables us to comprehend many phenomena which were necessarily quite erroneously interpreted by the older helminthologists, who were ignorant of these wanderings and unacquainted with the occurrence of the Alternation of Generations. It is a common thing to find capsules or cysts, in the midst of the tissues of the most widely different organs of men and animals, containing asexual and only partially developed intestinal worms. It was difficult to understand how such living Entozoa could have originated in the viscera of animals (sometimes in those which are deeply seated and cut off from all external communication) and could here propagate their kind. Hence it was taken for granted that they had been produced by equivocal generation from the surrounding parts, and the mode of origin thus assumed, conversely furnished the reason why these *Entozoa* were unprovided with sexual organs. Frequently too, free, young, or imperfectly developed intestinal worms were met with in the substance of organs, and their occurrence was in the same way attributed to equivocal generation, though in reality these *Entozoa* were either in the act of emigrating or of immigrating,

or else, having found a resting place in some organ, were tarrying till the creature they infested should be swallowed by some other animal, when the passive immigration for which they waited would take place.

Many wandering parasites are unresistingly suffered to bore their way into and remain in, the organs of animals, whilst on the other hand, certain kinds are arrested and finally stopped, by becoming enclosed in a coagulable lymph thrown out by the organs which they traverse. Hereafter we shall have to distinguish two kinds of encysted intestinal worms. In the one kind the cyst is thrown out by the parasite itself, as I have already explained in the case of the *Cercariæ* ; in the other, the organ in which the encysted parasite lies imbedded, furnishes the walls of the cyst. These last "extrinsic" cysts are easily recognised in the passively encysted parasites of vertebrate animals, being immediately and intimately connected with the neighbouring tissues and traversed by blood-vessels.

In such capsules or cysts are found the most diverse kinds of intestinal worms, whose further course may be very various.

Many of the encysted young of the intestinal worms experience no further change, but only remain for a longer or a shorter period until such time as they may, together with their host, pass into the intestine of some animal of prey suitable for their future development. To this kind belong the *Cercariæ* I have already mentioned (page 20). There is also a small, imperfectly developed, round worm, hitherto always erroneously described as a perfect intestinal worm, under the name of *Trichina spiralis*, which remains a long time in its cyst without either growing or developing sexual organs. This minute *Trichina spiralis* is not only met with in the substance of the muscles of man, but also in the pleura and peritoneum of the most widely different kinds of vertebrate animals, enclosed in oval capsules about a quarter of a line in length. Most probably a certain time of imprisonment is allotted to the little worm, and after this period has elapsed, should its deliverance not be effected by passive emigration, it dies, and its body, which has not in the least increased in size, is, without changing its outward form, transformed into a brittle glassy mass composed of carbonate of lime. This process of calcareous degeneration also takes place in other encysted and dead intestinal worms, in which, however, the form does not always remain

perfect, but is either more or less altered, or else entirely destroyed.

Other encysted intestinal worms succeed in obtaining nourishment through the walls of their prison, and thus go on growing. Those, however, amongst the encysted entozoa, which are intended by nature to attain their sexual maturity only in the digestive organs of certain animals, cannot arrive at this condition in their cysts, and must, in spite of their further growth, fail in the attainment of the power of sexual propagation, until the animal they inhabit is devoured by the predacious creature, whose intestine is alone fitted to allow of the passage of these asexual intestinal worms into the last stage of their development. I may cite here, as examples, various *Nematoidea* and *Cestoidea*. In many marine fishes the liver is covered with capsules, which often contain a well-grown nematoid worm more than an inch long. Naturalists have arranged this parasite among the intestinal worms as *Ascaris capsularis, Filaria piscium, Filaria cystica.* I have never met with one of these round worms containing developed sexual organs. As in their further organization no less than in their whole form, these ascarids most strikingly resemble certain sexually-mature nematoid worms, namely, *Ascaris osculata, spiculigera, angulata, aucta,* and others, which infest the alimentary canal of seals, cormorants, divers, gulls, and predacious fishes, the idea presents itself that these encysted, not yet fully developed *Nematoidea* belong to either one species or another of the last-named *Ascaridæ*. More particular inquiries into the subject will instruct us what species of these round worms, which are now considered to be distinct species, will hereafter have to be united into a single group, as younger or older individuals of one and the same species. The sexless *Ascaris incisa*, represented in fig. 17,

Fig. 17.

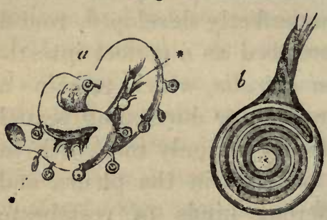


Fig. 17. A convoluted piece of the intestine of the mole (nat. size), with many flattened, pedunculated cysts, each enclosing a little thread-worm, attached to its peritoneal investment. * * Such cysts viewed edgewise. *b*. A single capsule much magnified, so as to render the enclosed thread-worm more clearly visible. This parasite belongs to that group of the *Ascaridæ* whose intestine is provided anteriorly with a cæcum directed upwards.

which occurs encysted in the peritoneum of the Mole, must also be awaiting its transference to the intestine of some other anial, where it attains its sexual maturity.

From what has been stated we gather, that those young intestinal worms which are developed at a distance from the nidus of their parents, succeed, in the end, in reaching those situations where they may repeat the part of their progenitors, and reproduce their kind. Impelled by instinct, the embryo parasites, that have only just left the egg, disperse in all directions, so that they may immigrate into other animals, whenever an opportunity offers. Many thousands of these embryos of necessity never attain their object, on account of the numerous casualties that beset them in their wanderings. The point of most importance is, that these embryos should select, as their temporary residence, such creatures as will be consumed by those animals, whose intestine served their parents, as a habitation and birth-place for their young. But many of these young, immigrated, intestinal worms will have undertaken their journey in vain, and will die without reaching the last stage of their development, in consequence of their host and involuntary carrier, escaping from his natural enemies. Again, many embryos will be led astray by the migratory impulse, and pass into animals which never become the prey of those whose digestive canal is their goal. This I conclude from the frequent occurrence of one and the same kind of encysted parasite amongst the most various kinds of animals. And I shall regard those embryos which have failed in their object, in the way I have mentioned, as parasites which have *strayed* in their wanderings.

I know that there may be some difficulty in accepting this theory of *strayed* parasites; it will be urged that these, like all animals, have a sort of instinct implanted in them which never allows them to enter upon any fruitless undertaking, and which, without their knowing it, impels them to strike out the right path in their wanderings. If this were really the case, every tænioid embryo must some day become a tape-worm, and we should be so overrun with nematoid worms that, judging from the enormous quantity of their eggs, the animals they infest would perish by wholesale from their countless numbers. Those who have occupied themselves with the collection of intestinal worms, must only too frequently have remarked, however, that these parasites are by no means so numerous as the immense numbers

of their eggs would lead one to suppose. This inclines one more readily to the belief that nature, seeing how full of difficulties is the way of these parasites to sexual development, has endowed them with the power of generating millions and billions of eggs, when once they have overcome these obstacles and developed the necessary sexual organs. Through the unceasing spread of cultivation, the decrease and extirpation of certain animals, on the one hand, and the taming and increase of domestic animals on the other, the conditions of life of many of the intestinal worms have become so changed, and so widely different from their original state, that, with their inherent tendency to wander, many of these parasites must often go astray.

The *Trichina spiralis*, which is found in human beings, and which, as I have already shown, must be regarded as an encysted sexless nematoid worm, can hardly have found its way into the muscular substance of man, except by having gone astray; so also the *Cysticercus cellulosæ*, which not unfrequently appears in the muscles and other organs of man, and which, as I shall hereafter show, is an asexual tænioid agamozooid. The *Cysticercus cellulosæ* changes to a sexual tape-worm in the intestinal canal of certain mammals; the *Trichina spiralis*, after transportation to another and more favorable situation, will also become sexually developed. That these two parasites should have been originally intended to pass into and establish themselves in, human beings, waiting for the opportunity to emigrate, which could only occur when the person who harboured the sexless parasite should be devoured by some appointed beast of prey, is an idea insufferable to the dignity of man,[1] which every reader of these lines must of necessity reject; and admit, instead, that the appearance of these parasites in the interior of man can only be accounted for by the fact of their having gone astray.

Many of the young of the intestinal worms which only attain the last stage of their development in the digestive canal of the *Vertebrata*, chance, in the course of their wanderings, to pass into the wrong organs; for instance, into the muscular substance, the liver, or the peritoneum; here they remain undeveloped,

[1] To appeal to the "dignity of man" in a zoological argument appears a little out of place. Nature seems to have had small respect for our "dignity" when she created the fleas, lice, and bugs which annoy us; the *Ascaris*, which reduces us below the level of the beast; the *Strongylus*, and the *Echinococcus*, which destroy us outright.—[Ed.]

whilst other individuals of the same brood, which have found their way into the intestine of the same animals, arrive at maturity. *Triænophorus nodulosus,* infesting fishes, offers an example of this, developing into a long, sexually-mature tape-worm, in the intestines of pikes and perch, whilst at the same time these fishes often harbour other tape-worms, which are, however, always sexless, in cysts in their liver. These last must certainly be also regarded as strayed parasites.

In these wanderings through the bodies of vertebrate animals, the very small embryos of the intestinal worms, boring their way through the walls of the blood-vessels, not unfrequently fall into the current of the circulation, and so become distributed with the blood. In fact, embryos of intestinal worms, to which the name of *Hæmatozoa* has been given, have often been discovered in the blood of birds, reptiles, and fishes.[1] These *Hæmatozoa* neither become further developed in the blood, nor increase in size; but many of them, whilst circulating in the vascular system, stick in the narrow blood-vessels of certain organs which afford a more congenial soil for their further growth; such at least is the most natural way of accounting for the appearance of intestinal worms in the brain, in the spinal marrow, and in the eyeball of man and animals. These organs are so completely enclosed, partly by bones, and partly by dense fibrous membranes, that before the existence of animals in the blood was known, it was supposed quite impossible for parasites to penetrate into such well protected organs; but that they must have originated then and there through equivocal generation. The *Cysticercus cellulosæ,* the *Cœnurus cerebralis,* and the *Echinococcus hominis* and *Veterinorum,* have long been known as occasional denizens of the brain and of the spinal marrow in men and animals, and have, up to the very latest times, served as a stronghold for the supporters of the doctrine of equivocal generation. Having subjected these very cystic worms to particularly close investigation, in order to confute this fabulous hypothesis as to

[1] I have collected together the different observations on hæmatozoa in the article "Parasiten" in Wagner's 'Hand-wörterbuch' already referred to (p. 648); subsequently, new facts of the same kind have been published by Ecker (Müller's 'Archiv.,' 1845, p. 501), Wedl (in his 'Beiträge zu Lehre von den Hämatozoen,' Wien, 1849), and Leydig (in Müller's 'Archiv.,' 1851, p. 227).

[See also the remarkable observations of Bilharz, 'Ueber das Distoma hœmatobium,' 'Zeitschrift für Wiss. Zoologie,' 1852. This diœcious hæmatode is found in the portal blood of man.]—[Ed.]

their mode of origin, I will give an account of the results below.

With the migrations and alternation of generations amongst the intestinal worms, two other phenomena are connected, which were formerly quite unnoticed, but which now, since attention has been directed to them, have been very generally observed. In the neighbourhood of those sexually perfect intestinal worms which, in their wanderings, are subject to the alternation of generations, only eggs, or recently hatched embryos are met with; but the further stages of development are always wanting, since they first make their appearance after the emigration of the young to other places. Further, many of these intestinal worms, taken whilst in the act of migrating, are never found below a certain size, since they do not commence their wanderings, either as nurses or larvæ, until they have already reached a certain stage of their development.

In this chapter I have expressed myself somewhat at large upon the wanderings and alternation of generations of the intestinal worms, in order that I may be fully understood in the ensuing ones, when I have occasion to refer to this generation by agamozooids. The history of the propagation of certain parasites, in the foregoing pages, may seem new and astonishing to many readers, and yet the alternation of generations is not more wonderful than metamorphosis. We have been so long acquainted with the way in which metamorphosis takes place in the higher and lower members of the animal kingdom, that we no longer wonder at the various transformations of the frog, nor gaze with surprise when a caterpillar becomes a chrysalis, and after a certain time flies off in the shape of a butterfly. The many to whom the metamorphosis of frogs and insects is a common appearance, forget that there was once a time when it was unknown, and when the multiplication of grubs and larvæ was ascribed to equivocal generation, their true origin being unsuspected. It is to be hoped that a time will also arrive when the complicated alternation of generations will not be known to naturalists alone.

CHAPTER II.

ON THE TAPE-WORM.

THE tape-worms (*Cestoidea*) constitute a peculiar group of entozoa which only attain their perfect development and sexual maturity in the intestinal canal of vertebrate animals. Those that are often met with in other internal organs than the intestinal canal, in fishes, reptiles, birds, or mammals, or in the interior of inferior animals, are always sexually undeveloped. In this sexless state the tape-worms wait for an opportunity to pass out, which occurs when the creature they lodge in is swallowed by some vertebrate carnivore. It is only when such sexless tape-worms have thus passively effected their entrance into the intestinal canal of the appropriate *Vertebrata,* that their sexual maturity takes place, and they become capable of laying eggs for further propagation. In this wandering the remarkable circumstance occurs, that whilst these undeveloped tape-worms pass into the stomach of the predacious animal in a more or less uninjured condition, and establish themselves in its intestine, the soft parts of their former host yield to the digestive juices. Numerous examples attest the truth of this assertion, but of these I will only select the following.

In certain neighbourhoods the sticklebacks are infested by a kind of tænioid parasite which lies free in the cavity of the abdomen, and often distends the body to an unusual size. This parasite has been before described under the name of *Bothriocephalus solidus.* In the stickleback its joints and sexual apparatus are undeveloped and always remain so.

In the intestine of many of the water fowl which prey upon these sticklebacks, a sexually matured tape-worm, known to naturalists by the name of *Bothriocephalus nodosus,* has been found. This is no other than the *Bothriocephalus solidus* in a further stage of development; after its former host, the stickleback, has been digested in the bird's stomach, it is released,

and entering uninjured into the intestine of its new owner, arrives at sexual maturity. The extent of development in each individual will be found to be in proportion to the time it has passed in the bird's alimentary canal after its passive emigration. Since the connection between *Bothriocephalus solidus* and *nodosus* has been known, helminthologists have ceased to regard these two tænioid worms as different species, but in accordance with the suggestion of Dr. Creplin, who first drew attention to the relationship between them, they have been considered to be different stages of the same species, *Schistocephalus dimorphus.* A similar instance occurs in the case of the *Ligula simplicissima,* infesting the abdominal cavity of various species of carp, whose sexual organs are, and remain, undeveloped, as long as the worm remains within the fish, whilst when the latter is eaten by, and the entozoon thereby conveyed into the intestines of, ducks, divers, waders, and other water-fowl, it attains perfect sexual development. In the older helminthological systems the sexually matured *Ligula simplicissima* is described under various specific names, sometimes as *Ligula sparsa, uniserialis,* sometimes as *Ligula alternans,* or *interrupta.*

Many *Cestoidea,* during their youth, lodge in the liver and peritoneum of fishes. In these organs they excite a morbid exudation whereby a membranous substance is produced, which forms a kind of capsule round the worm, and thus, as it were, excludes it from the organism. This act, by which the organs seek to free themselves from such unwelcome guests, I shall designate by the name of "extrinsic"[1] encysting process already given in page 25.

The encysted *Cestoidea* increase in size, but do not become sexually mature, from the absence of the conditions necessary to the attainment of this state; and should their hosts perish without having been devoured by an animal of prey, the sexless *Cestoidea* will die with them, without leaving any progeny. Various examples illustrate the truth of this statement.

Mention has already been made (at page 29) of the *Triaenophorus nodulosus* which infests the intestine of the pike and the perch, where alone it is to be met with sexually mature. Helminthologists, however, give other localities of this worm, as

[1] I have added the word "extrinsic" here to distinguish this from the self-encysting process by exudation from the entozoon itself.—[Ed.]

certain species of salmon, for instance; but in these it is met with encysted in the liver and peritoneum, and is invariably sexless. The examination of the livers of a great number of the *Salmo salvelinus* caught in the Königs-see, near Berchtesgaden, recently convinced me that this worm can only attain to sexual maturity in the alimentary canal of perch and pike. These livers were covered with various sized cysts containing larger or smaller individuals of *Triænophorus nodulosus,* which were every one sexless. The *Cestoidea* were obviously awaiting their sexual development, which could only take place when they should have passed into the intestine of a pike or perch, a migration which may easily occur, since the lake is full of such predacious fish, who are always ready to seize upon the salmon. When the *Triænophorus nodulosus* has come to sexual maturity and has deposited its eggs in the intestine of the pike and perch, these eggs will be passively extruded, since the cestoid embryos are never hatched in the spot where they have been laid; that is to say, they will be expelled with the fæces through the anus of the fish. With regard to the ultimate fate of the young of the *Triænophorus nodulosus,* I can state nothing from actual knowledge, but from what has been observed in regard to other intestinal parasites, I think one may infer that the young of the former will be impelled by the same instinct, to wander, and to seek that situation which can alone develop their powers of reproduction. Although I am unacquainted with the form in which the embryos of the *Triænophorus nodulosus* commence their wanderings, yet, having found tolerably large individuals of this species encysted in the livers of various fishes (of salmon, sticklebacks, millers' thumbs, burbot, blennies, and others), I conclude that the young *Triænophori* have merely made these a temporary resting-place, and are waiting till their host becomes the prey of the above-named fishes. Whether the young of the *Triænophorus* always avail themselves of an intermediate host by whom they may be conveyed into the intestine of their final entertainer, the pike or perch—I cannot say. It is possible that they may pass, at once, into the pike or perch whenever an opportunity offers; but under these circumstances it would be by no means immaterial into which organ of the fish they first entered. Since the intestinal canal is the only proper place for their sexual development, they will, by passing into the liver or

3

peritoneum, most assuredly meet with the same fate as if they had entered the other fishes; they will become encysted, and may grow within the cysts, but will not become sexually mature unless their owner be swallowed by a larger creature of his own kind.

Similar migrations and strayings from the right path are exhibited by the *Tænia longicollis* and *ocellata,* which are met with, not only in the intestine, but also encysted in the livers, of salmonoid and percoid fishes, in a jointed but sexless state. I must call attention to the fact that the *Triænophorus nodulosus,* in its sexless condition, is not uncommonly found in the liver and peritoneum of the sticklebacks; and as this fish, on account of its spines, is generally avoided by the pike and perch, the immigrated young of the *Triænophorus* in the stickleback must be certainly regarded as having gone astray.

The various species of the cestoid genus, *Tetrarhynchus,* enumerated by systematic helminthologists, are nothing more than imperfectly developed, sexless forms of *Cestoidea,* which, in their fully developed and sexually mature condition, have been regarded as belonging to an entirely distinct genus. Following Rudolphi, later helminthologists termed this latter genus, *Rhynchobothrium.* The genus *Tetrarhynchus* must now, however, be set aside, since the forms of animals hitherto included in it must be considered as younger stages of development of true *Rhynchobothria.* The head end of many kinds of *Tetrarhynchus,* with its four protractile proboscides, armed with numerous sharp grappling hooks and provided with four moveable suckers, in form and organization resembles so exactly the fore part of the *Rhynchobothria,* that there is no doubt as to the origin of the former.

The *Rhynchobothria* in their full grown and sexually matured state, are only found in the digestive canal of plagiostome fishes. In order to secure their migration into other individuals of this order, the young of the *Rhynchobothria* make use of such marine creatures as serve the former for prey. As the ravenous shark or ray is not over nice in the choice of its food, it is not necessary for the young *Rhynchobothria* to select any particular marine animal as its temporary host, in order to introduce itself into their intestine. Indeed one meets with *Tetrarhynchi,* (that is to say young *Rhynchobothria*), in soles, flounders, mullets,

in cod-fish, gurnards, congers, and even in cuttlefishes. From the encysted condition in which the parasites are found in these animals, it is easy to see that they have only made them their temporary abode. That they are by no means at home in these intermediate hosts seems evinced by their lively and restless proceedings; their four protractile feelers, with their countless hooks, being employed most cleverly, to bore through the flesh, the walls of the stomach, and the tunics of the various organs.

The head end of the young *Cestoidea* takes, at a very early period, the form of that of their sexually matured parents, whence it is easy to distinguish to which species of cestoid worm they belong. According to Van Beneden's suggestion, helminthologists have designated such undeveloped sexless *Cestoidea* whose heads have already assumed the parental form, as "scolices." From their physiological signification these cestoid scolices have been compared with the larvæ of insects; the comparison, however, is not tenable, since every insect larva leaves the egg in its larva-form, and is gradually changed into an individual insect capable of propagation, whilst the scolices of the *Cestoidea* do not come forth from the egg in the condition of scolices, nor are converted into a reproductive tape-worm individual, but by sexless generation give birth to a great number of sexual individuals. Here, therefore, we have to do, not with metamorphosis, but with an alternation .of generations in which the scolex-forms play the part of agamozooids.

In studying the history of the *Cestoidea*, it must be strictly borne in mind that all scolices, whatever be their form, are only different stages of cestoid worms; and, on the other hand, that the cestoid embryos leave the egg in a form widely different from a scolex. The embryos of the genera *Tænia* and *Bothriocephalus* are precisely similar, widely different as are the forms of the so-called "heads" of these worms subsequently. The whole organization of these embryos seems specially adapted for the purpose of digging and boring, a circumstance most favorable to them in their wanderings. They possess, in fact, a very small rounded body, (fig. 18 *a*), at one end of which six little hooks or claws project, two in the middle and two on each side. Each pair of these hooks is differently shaped from the others (fig. 18 *b, c, d*), and they are so arranged, that one of each form is placed on each side of the embryo, so that the two innermost, the two middle,

and the two outermost hooks are alike.[1] If one of these embryos is set free (which can be effected by carefully crushing the eggshell between two plates of glass), without destroying the living tape-worm embryo, its various movements may be examined under the microscope. It draws its round body together, and enlarges and contracts its transverse diameter, and by this operation protrudes, first in front and then at the sides, the six little hooks from that end of its body which, from these hooks being situated there, I shall call the fore part. The observer can readily understand how, by such movements, the excessively minute cestoid embryo succeeds in boring its way into the moist and tender soft parts of other animals and in traversing their interior in all directions.

Fig. 18.

When the cestoid embryos have, by immigration and subsequent encysting, lodged themselves in an animal by whose means they will eventually become introduced into the alimentary canal of one of the *Vertebrata*, and so reach the last stage of their development, a remarkable metamorphosis takes place by which they pass from the condition of embryos into that of scolices. In the interior of the embryo an organ is developed which gradually assumes the characters of the head of a cestoid worm, and always resembles that of the particular species from which the embryo has been produced. When once the head of the cestoid is fully formed it may become extruded from the interior of the body, and the entire worm then constitutes a scolex. The whole of this process of scolex-development may be justly compared to an internal budding.

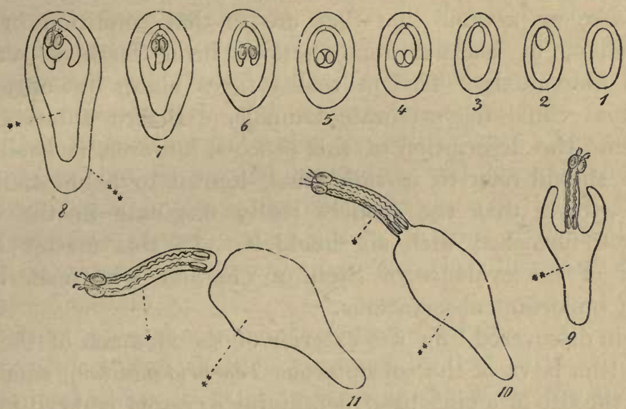
According to the view of the earlier helminthologists, the scolices consist of the head end of a cestoid worm, out of whose posterior extremity the proper body is subsequently developed. In regard to the organization of the scolices, it must be particularly noted that they possess no oral aperture, and are only nourished by the absorption of fluids through the surface of their

Fig. 18. The embryo of *Tænia crateriformis.* The six hooklets are formed upon three different types; *b*, *c*, *d*, represent the three kinds more highly magnified. *b*. One of the two uppermost, *c*, one of the two median, and *d*, one of the two outermost hooklets.

[1] See my description of these hooks in Burdach's 'Physiologie,' Bd. ii, 1837, p. 204.

integument. In the substance of their bodies, spherical or discoidal bodies of a glassy appearance are often seen: these

Fig. 19.



have frequently been mistaken for eggs, whereby the nature of these creatures has been wholly misconceived. The particles are, in fact, nothing more than organized deposits of carbonate of lime. Integumentary concretions of the same kind are found in many other of the lower animals. The scolices have also been described as young cestoid worms: we shall, however, more readily comprehend the various stages through which the *Ces-*

Fig. 19. Series of developmental stages of a *Tetrarhynchus*, or rather of a scolex of *Rhynchobothrium*, represented diagrammatically, and partly after Van Beneden. The cestoid embryo becomes a *receptaculum scolicis* by the development of a scolex in its interior. With the progressive development of the scolex the body of the embryo (*receptaculum scolicis*) and the cyst containing it, increase in dimensions. 1. The encysted embryo. 2. The encysted embryo developes a bud internally, and so becomes the receptacle of a scolex. 3. The internal bud out of which a scolex is being developed has increased in size. 4. In the interior of the bud the head of the future *Tetrarhynchus* appears, and the suckers become perceptible. 5. The head of the *Tetrarhynchus* becomes more clearly defined; and, 6, acquires a neck. 7. The neck elongates, the four hooked proboscides make their appearance. 8. The more elongated neck is forced to become curved in order to accommodate itself to the narrow space in which the scolex is undergoing its development. 9. The adult scolex out of its cyst, and beginning to be extruded from its receptacle. 10. The extruded scolex; which, in 11, has separated itself from its receptaculum. In this condition, the scolices of the *Rhynchobothria* have hitherto been described as species of *Tetrarhynchus*. * Scolex. ** Receptaculum scolicis. *** Cyst. For the further development of the *Tetrarhynchus* into a *Rhynchobothrium*, see fig. 23.

toidea pass, and be better able to bring them into unison with the phenomena presented by the other entozoa, if, as has been suggested above, we regard the scolices as agamozooids.

In taking this view of the nature of the scolices of the *Cestoidea*, we assume that they are in that condition in which they may, by asexual reproduction, bring forth a series of sexual individuals. This in reality takes place, but only in the intestinal canal of vertebrate animals. Before entering more fully into the description of this process, however, it is advisable that I should refer to certain facts, known to helminthologists, which prove that the scolices really originate in the cestoid embryos furnished with six hooklets. In this matter I avail myself of the evidence of Stein of Tharand, who made the following important observations.

Stein discovered,[1] on the exterior of the stomach of the meal-worm (the larva of the coleopterous *Tenebrio molitor*), small cysts about the size of a pin's head, containing a cestoid embryo in whose body a more or less fully developed scolex was included. In those that were fully developed Stein recognised a perfect *Tænia* head. Stein distinctly convinced himself that the *Tænia* embryo did not become a scolex by simple growth, but that the latter was produced by budding in the body of the embryo, having, amongst the numerous cysts that he examined, the most various transitional forms, from the simple unaltered embryos to those containing a fully developed scolex. During this development of a scoliciform agamozooid the embryo changes its form, growing rather longer on the one side than the other, in consequence of which its six hooks become irregularly scattered over the upper surface of the body and lose their import (fig. 26); a clear proof that they do not enter into the formation of the circlet of hooks of the tænioid scolex. It is clear that these tænioid embryos arrive by immigration into the abdominal cavity of the meal-worms, and in fact, as Stein suspected, through the walls of the stomach; for this observer more than once found tænioid embryos in the stomach of meal-worms, which, judging from their form, could only just have been hatched. Most likely these minute embryos had been taken in with their food by the meal-

[1] See his 'Beiträge zur Entwickelungsgeschichte der Eingeweidewürmer,' in the 'Zeitschrift für Wissenschaftliche Zoologie,' edited by Kolliker and myself. Bd. iv, 1853, p. 207.

worms, and so conveyed into the stomach. By the help of their six hooklets they pierce its walls and pass into the perivisceral cavity. Having got thus far, the immigrated tænioid embryos find in the meal-worms a fitting intermediate residence, and the scoliciform agamozooid begins to be developed in them. The embryos having thus completed their wanderings, and arrived at their appointed end, throw off their boring apparatus, and play a more subordinate part, the scoliciform agamozooid developed within them, henceforward taking the chief place. The scolex is itself sexless, but by asexual generation will bring forth sexual individuals; this, however, can only take place in the intestine of some vertebrate animal, and it is now the turn of the scolices to wander, in order that they may pass from their intermediate host into their final one.

In doing this the nurse is entirely passive, waiting until its intermediate host shall be devoured by that particular vertebrate animal which is fitted to serve as the nidus for its sexual stage. What vertebrate animal this is, is at present unknown, so that I can only speak conjecturally, and indicate that these meal-worms are the favorite food of various small mammals, such as rats and mice, and of numerous birds, the red-start, for instance; and that the *Tenebrio molitor*, which flies about, and is produced from the chrysalis of the meal-worm, is often caught and eaten by bats, swallows and other insectivorous animals. A minute comparison of the scolices of the meal-worms with the heads of tape-worms from the intestines of the animals I have named, may perhaps assist in filling up the gaps in these observations.

Another observation made long ago by myself, and which has since been more fully worked out by Dr. Meissner, serves to confirm the observations of Stein. In the substance of the pulmonary sac of *Arion empiricorum*, (a slug), I discovered many encysted scolices,[1] from the shape of whose heads I judged that they formed part of the developmental series of a *Tænia*. The form of these scolices, is, however, very different from that of those which are found in the meal-worms. Their head end is always involuted in the short, and only partially developed, hinder part of the body (fig. 20, 21).

One sees in the whole arrangement of the various parts of the

[1] See my essay 'Ueber den Generationswechsel der Cestoden,' in the 'Zeitschrift für Wissenschaftliche Zoologie,' 1850, p. 202.

encysted scolex with the retracted head, that the latter is produced in exactly the same manner as that of the meal-worm scolex described by Stein, viz., by internal budding, although I have never chanced to meet with such earlier stages of development of the scolex in the slug. However, that they do directly emanate from *Tænia* embryos, is evidenced by the three pair of hooks or claws, which are firmly fixed in the substance of the surface of the posterior extremity of the body of these retracted scolices. We are indebted to Dr. Meissner for the discovery that these six claws are the remains of the embryonic condition of these cestoid agamozooids.[1] The encysted scolices in the slug, therefore, are perfectly analogous in form and signification to the cestoid agamozooids in the meal-worm, with this difference, that the first are not elongated into a tail at the posterior extremity. The encysted cestoid agamozooids in the slug are evidently the result of the immigration of cestoid embryos, and yet in spite of the fact that these parasites are very frequently met with in slugs,[2] I have not been able to determine which species of *Tænia*-embryo passes into this form of scolex, nor into the intestine of what particular vertebrate animal the scolex of the slug must emigrate, to give rise to sexual individuals.

Fig. 20.

Fig. 21.

The sexually matured individuals of the *Cestoidea* are no other than their full-grown joints; in which are developed the male and female genitalia, by whose co-operation eggs capable of reproduction are generated, and the continuation of the species is secured. Such a sexually-mature, hermaphrodite joint of a cestoid worm, which, in certain genera of *Cestoidea*, when fully formed, separates from the body of the scolex with great readiness, is denominated a *Proglottis*. The formation of these

Fig. 20. A scolex of *Tænia* from *Arion empiricorum* included within its receptacle. Fig. 21. The same extruded. *a*. Head of the scolex. *b*. Receptaculum scolicis. *c*. The remains of the six embryonic hooklets.

[1] See the ‘Zeitschrift fur Wiss. Zool.,’ B. v, 1854, p. 383.

[2] I have found, not only in Breisgau, but also in Schleswig, and here in Bavaria, the lung of the red slug (*Arion empiricorum*) very frequently infested by the encysted scolices referred to above; and I learn from Dr. Meissner that the same is the case with the slugs found in the neighbourhood of Hanover.

Proglottides takes place at the posterior end of the scolex by asexual reproduction; viz., by a simple process of growth and division. If we compare this process with the phenomena of the Alternation of Generations, we shall discover in it all the essential characters of the latter. The matured joints, or the sexual individuals, of the *Cestoidea* in their proglottis form, produce a brood of embryos armed with six hooklets, which are quite dissimilar in shape from their parents, the *Proglottides,* and remain so, since at a later period they assume the scolex form, and take on the functions of an agamozooid. From the posterior end of the body of such a scoliciform agamozooid a series of joints are developed; that is to say, a generation of sexual individuals, which again present the original proglottis form. In their organization, the *Proglottides,* apart from their sexual apparatus, so far resemble the scolices, from which they have been produced, that they possess no oral aperture, and moreover are subject to a deposit under their integument, of those glassy calcareous particles which I have already mentioned.

It seems, at first, paradoxical to say that the joints of a tape-worm, which have hitherto been believed to be mere parts of one animal, should be considered as individuals; but whoever will observe, with an unprejudiced eye, a fully developed *Tænia* with its sexually matured joints, must be convinced that it is no simple animal, but one composed of many individuals. The joints of a *Tænia,* when quite mature, become detached from one another with the greatest ease; the separated joints for a long while preserve their form and remain quite fresh and lively, being even capable of locomotion, and always seeking to disburden themselves of their eggs before dying. Even the older naturalists had regarded the single, separate joints of a *Tænia* as separate individuals, whilst others again, described the joints of the common tape-worm of Man, (*Tænia solium*), as "*Vermes cucurbitini.*" Later helminthologists, however, rejected the idea that a *Tænia* was composed of "*Vermes cucurbitini,*" and especially objected[1] to the view of Vallisnieri and Coulet,[2] who maintained that the *Tæniæ* were produced by the mutual adherence of a number of the cucurbitine worms into a complex, jointed whole.

[1] See his 'Considerazioni ed Esperienze intorno alla Generazione de' Vermi del Corpo umano.' Padooa, 1710, p. 63.

[2] 'Tractatus de Ascaridibus et Lumbrico lato.' Lugduni Batavorum, 1729, pp. 37, 56, &c.

Blumenbach stood almost alone among the later naturalists, when, to the astonishment of his contemporaries, he defended the incorrect views of Vallisnieri.[1] The older inquirers were quite right in regarding the various isolated *Tænia*-joints as separate individuals, though they certainly fell into a gross error in imagining that the long, many-jointed *Tænia* was composed of coalesced *Vermes cucurbitini*; in point of fact it is exactly the reverse, the *Vermes cucurbitini* owing their origin, to the breaking up of the *Tænia* into separate joints. That the first impression of these old naturalists was a just one is evident, from the circumstance that even modern helminthologists, meeting now and then with solitary *Tænia*-joints, with whose origin they were unacquainted, have regarded them as peculiar individual worms, and described them accordingly. A remarkable intestinal worm described many years ago by Diesing, under the name of *Thysanosoma actinoides*, which was found in the intestine of a species of deer from Brazil, created much sensation amongst helminthologists, until Diesing himself, not long ago, acknowledged it to be an isolated joint or *Proglottis* of *Tænia fimbriata*.[2] Dujardin described the isolated joints of various *Cestoidea* as forms of a peculiar genus of worms, to which he gave the name of *Proglottis*.[3] Although he believed them to be originally derived from *Tæniæ*, he was, notwithstanding, so firmly convinced of their independent existence, that he made them into a separate genus in his systematic arrangement of the *Cestoidea*.[4] However, since more has been known of the alternation of generations, whereby the origin of one animal from another of quite dissimilar form, and their mutual relations to each other have been explained and familiarized, helminthologists generally admit that a cestoid worm is really a colony of animals. How difficult naturalists formerly found it, to accede to a view that since the time of Blumenbach had been a subject of ridicule,

[1] 'Gottingischen Anzeigen von gelehrten Sachen,' 1774, No. 154. Blumenbach regards the anterior, smallest, joints of a tape-worm as the oldest, and he accounts for their being smaller than the posterior joints by supposing that they have to give up the nutriment which they take in, to their successors which have fastened on to them behind. He compares these worms to the mass of authors, the more modern of whom merely suck out of their immediate predecessors, that which these had extracted in the same way from still older writers.

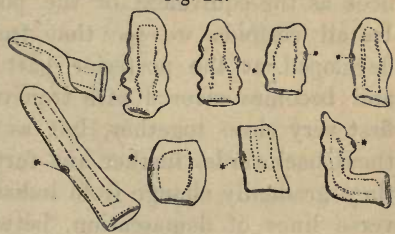
[2] See his 'Systema Helminthum,' i, 1850, p. 501.

[3] 'Annales des Sciences Naturelles,' t. xx, 1843, p. 341.

[4] 'Histoire Naturelle des Helminthes,' 1845, p. 630, pl. 10, figs. A, B, C.

is shown by F. S. Leuckart, who, rightly appreciating the true meaning of these jointed *Cestodea,* and yet apparently not liking to oppose his contemporaries too strongly, merely expressed himself thus upon the matter.[1] "I was almost inclined to consider the jointed tape-worms as organisms, in which each joint is a separate animal, and the whole a compound animal, as has been before supposed by many distinguished zoologists." Steenstrup returned to the idea (loc. cit., p. 103) that the tape-worms are compound animals, and subsequently, Van Beneden[2] in his admirable monograph, has pointed out and illustrated with excellent figures many striking and conclusive examples of the truth of the same view. In looking at Coulet's (l. c., figs. 2—16,) illustrations of the separate joints (*Proglottides*) of a *Tænia solium* in their various states of contraction and expansion, (fig. 22,) it is impossible not to admit the conception that these animal bodies are independent existences. The separate joints (that is, the *Proglottides,*) of the other species of *Tænia* are perfectly similar to these; and the *Proglottides* described by Van Beneden in the cestoid genera *Echeneibothrium, Phyllobothrium, Anthobothrium, Acanthobothrium, Onchobothrium, Calliobothrium,* and *Tetrarhynchus*, (all characterised by clearly marked articulations), closely resemble them.

Fig. 22.



Since we must henceforward regard these *Cestoidea* as compound animals, we may compare the many-jointed tape-worm with a polypidom, although we must not forget that there are some points of difference between the two. In the compound polypes, the individuals bud out in various directions and relative positions from their parent stock, whereby the polypidom, accord-

Fig. 22. Single and separated sexually mature joints of *Tænia solium* (of the natural size) with lateral sexual apertures, (*) and in different states of expansion and contraction (after Coulet). Each of these separate joints must be regarded as a sexual individual of the *Tænia solium*, and is the proglottis of this *Cestoid* worm.

[1] 'Versuch einer naturgemässen Eintheilung der Helminthen,' 1827, p. 21.

[2] 'Les Vers Cestoides,' 1850. It is to be regretted that Van Beneden has confined his investigations to the scolices and proglottides, and has not examined the development of the embryos.

ing to its genus and species, receives a specific, ramified, foliaceous, or encrusting form, whilst in the compound tape-worms, the individuals only grow out of the common stock in one direction, and in a single series.

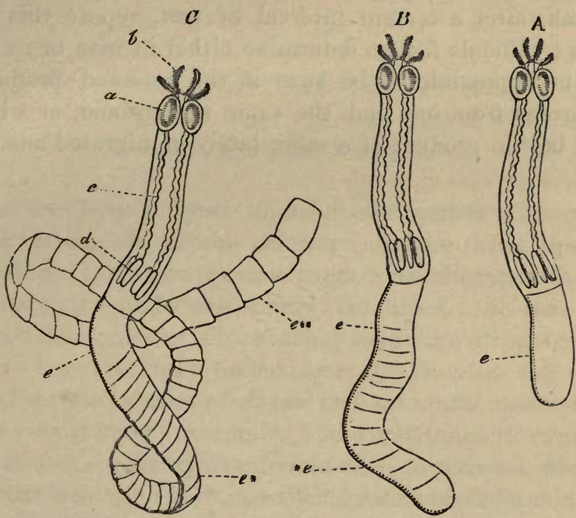
In the *Cestoidea* the stock is the posterior end of the scoliciform agamozooid. In the alternation of generations amongst the *Cestoidea,* there is this peculiarity, that the agamozooid preserves its efficacy and independence, whilst the agamozooids of other animals which undergo alternation either die after producing their brood or pass into it.[1]

We must consider the head of every cestoid worm as the agamozooid still remaining and capable of reproduction, and its neck as the equivalent of the posterior extremity of the scolex. In all cestoids we see that fresh joints are continually being developed at the posterior part of the neck, which lengthens and becomes covered with transverse folds. These folds are at first very close together, but as the process of growth throws them backwards, further and further from their place of origin, they gradually change from indistinct wrinkles into sharp transverse lines of demarcation, between which the substance of the body dilates into a joint (individual), and assumes its specific shape. At a later period, the rudiments of the hermaphrodite sexual apparatus make their appearance in the interior of the joints: and in proportion as the latter move backwards from their parent stock (the neck), so much the nearer do they approach to maturity, through progressive development of their sexual apparatus; and finally they separate themselves from their younger fellows as independent individuals. I must not leave the fact unmentioned that the formation of marked proglottidiform joints does not take place in all *Cestoidea.* In the genera *Tænia, Tetrarhynchus* and several others furnished with cephalic hooks and suckers, the development and individualising of the proglottides occurs in perfection. In the genus *Bothriocephalus,* although the joints exhibit a distinct demarcation, they show little inclination to become separate. In *Triænophorus* the articulation is still less marked; whilst in *Ligula* it is obso-

[1] The correctness of this statement appears to be doubtful. The stock of the "*Hydra tuba*" remains after giving rise to a brood of *Medusæ,* and neither dies nor can be said to pass into the brood. The like is true of those *Sertularidæ, Diphydæ,* and *Physophoridæ* which give rise to medusiform Zoöids; nor does it seem to be otherwise in the remarkable Trematode *Gyrodactylus* described by Von Siebold himself.—[Ed.]

lescent, being only denoted by imperfect transverse folds on the sides of the body. Here, in fact, many groups of hermaphrodite

Fig. 23.



sexual apparatus become developed close together, in the ribbon-like body of the full-grown agamozooid, but the parts which surround them do not break up into joints. In this respect we may compare a *Ligula*, as a compound animal, with certain polypidoms in which the individuals become, in a similar manner, less distinctly separate from the parent stock.

For how long a time the head end of the cestoid worm can play the part of an agamozooid, and how many sexual individuals such a tape-worm can produce, has not yet been certainly proved. The number of proglottides which a single scolex can bring forth,

Fig. 23. Represents, diagrammatically the metamorphosis of a *Tetrarhynchus* into a *Rhynchobothrium* (after Van Beneden, see also suprà, fig. 19). A. A *Tetrarhynchus* scolex, whose posterior extremity is growing and elongating. B. The elongated hinder extremity exhibits transverse wrinkles which indicate the boundaries of the future joints. C. The posterior end of the same scolex appears clearly jointed, *i. e.* provided with proglottides. The *Tetrarhynchus* has thus become a *Rhynchobothrium*. *a.* One of the four sucking disks. *b.* Protruded part of the four proboscides provided with recurved hooks. *c.* Middle portion of the four proboscidean tubes. *e.* Unarticulated portion of the body. *e** Transversely wrinkled portion of the body. *e*** Articulated part of the body giving rise to proglottides.

must, in many species, be enormous, since many hundred articulations may still be counted, in cestoid worms which have, for months, been giving off numerous joints every day. Whether a cestoid worm, after giving off a series of sexless individuals as joints, can, after a certain interval of rest, repeat this process, would be a difficult fact to determine either in man or in animals, since it is impossible to be sure if the renewed production of joints springs from one and the same agamozooid, or whether it may not be the product of a more lately immigrated one.

CHAPTER III.

ON THE CYSTIC ENTOZOA.

ZOOLOGISTS have hitherto founded the genera and species of *Cestoidea* on the characters presented by the head and by the fully developed joints only; and even these characters have been but superficially and imperfectly employed, so that a close revision of this order of *Entozoa* has long been necessary. This task has been recently undertaken by Diesing and by Van Beneden, but the labours of these two helminthologists have led them to very different results. The great point in revising the old genera and species of the *Cestoidea* is, to discover what forms of proglottis belong to certain scolices which are commonly found without proglottides (and which, therefore, have long been regarded as distinct genera of *Cestoidea*), and to unite these together. Diesing has not attempted to do this, having apparently no conception of the bearing of the alternation of generations upon the systematic arrangement of the lower animals.

On the other hand, Van Beneden, guided by the light of the alternation theory, has justly recognised and given due prominence to, the affinities of certain *Cestoidea*. To this end the different kinds of scolex require to be more carefully defined than they have hitherto been, and the use of the microscope becomes indispensable. The forms of the apparatus of attachment must be determined and compared with the utmost care, and those hooks and protractile proboscides, armed with more or less moveable hooklets, which are attached to the head of the scolices, are especially adapted, from their varying and well marked figure and disposition, to afford good generic and specific characters. If the form and arrangement of that apparatus of attachment of the *Tæniadæ* which is known as the circlet of hooks, of the proboscis which carries it, and of the sac which conceals it, had been carefully observed, the identity of many so-called species of *Tæniadæ* would long since have been recognised, and the close

relation of the *Cystica* with the *Cestoidea* would not have been a recent discovery. It must not be forgotten, however, that in very many *Tæniadæ*, the scolices lose their circlet of hooks with advancing age, and that in many *Cestoidea*, the suckers of the scolices undergo great changes of form when the development of proglottides commences; in consequence of which it is often very difficult to demonstrate the connection of the older and younger individuals of one and the same species of cestoid. The proglottides of the *Cestoidea*, again, considered as individuals wholly separate from the parental organism, present distinct specific characters, though they are not, perhaps, very obvious at first sight. In these it is the sexual apparatus more particularly which, forming as it does the principal mass of the proglottis, presents excellent specific characters, in the form, dimensions, number, and arrangement of its parts. Van Beneden has the merit of having paid particular attention to these particulars in distinguishing the different species of proglottis.

As I have already hinted, the cystic worms, which were made by Rudolphi into a distinct order of *Entozoa*, are so closely allied to the *Cestoidea* that they have no claim whatever to be regarded as an independent group. Since, in addition, various kinds of scolices have been regarded as distinct genera of *Cestoidea*, it is high time that zoologists should resolve to erase from their systematic arrangements all these groups, which are in reality, based only on our ignorance of the natural history of the *Entozoa*. How great a number of these improper genera have been introduced may be judged by the fact that out of the order *Entozoa cephalocotylea*, alone, established by Diesing,[1] and containing thirty-two genera, ten genera must be eliminated, namely, *Echinococcus, Cœnurus, Cysticercus, Piestocystis, Anthocephalus, Acanthorhynchus, Pterobothrium, Tetrabothriorhynchus, Stenobothrium, Scolex*. Many of the *Entozoa* arranged under these genera are merely the scoliciform agamozooids of other *Cestoidea;* a fact which is demonstrated not merely by their undeveloped and sexless body, but by their habitation, since they are almost all found, not in the alimentary canal of a vertebrate animal, but in its other viscera. Another portion of these genera consists of the cystic worms, which are also nothing but the scolices of certain *Cestoidea,* with this difference, however, that a portion of their body is enlarged into a vesicle.

[1] Diesing, 'Systema Helminthum,' i, p. 478.

To prove that the cystic Entozoa are the sexless and variously degenerated nurses of the *Cestoidea,* I must once again return to the already mentioned (page 36) development of the cestoid agamozooids. When the cestoid embryo has immigrated and established itself in any organ of an animal, it begins to develop a scolex by internal budding, which takes the form of a *Tænia*-head or of a *Tetrarhynchus*-head, &c., according to the origin of the embryo. The embryo then increases and becomes enlarged by the growth of the scolex, which it holds enclosed within the distended walls of its body. These walls pass internally into the neck of the scolex, directly over the spot whence the scolex sprung. On the external surface a funnel-shaped but narrow depression is developed opposite the scolex, from which a canal stretches through the neck of the scolex to its head. This canal, after the full development of the scolex, permits its evolution, by which means the hinder end of the scolex passes immediately into the body of the embryo. The fully developed scolex in the interior of the embryo appears as if it had drawn itself inwards by a process of involution; but observation teaches us that the scolex is originally developed in this involuted condition, instead of becoming retracted when it has attained its full development. The material required for the development of the scolex and of the embryo which invests it, is taken up by the latter by absorption through its integument. This absorptive power of the integument may vary in amount, and produce different results, which are, of course, dependent upon the quantity and quality of the fluids, and upon the special peculiarities of the organs of the animal in which the embryo has taken up its residence. Under particular circumstauces it may easily happen that an embryo should absorb, through the surface of its integuments, more nutritive fluid than is necessary for the growth and development of the scolex. The surplus nourishment then gives rise to exuberance of growth and to degeneration of the body of the embryo. The immediate consequence of the accumulation of absorbed and unemployed nourishing juices will be a vesicular enlargement of the embryonic body; and the cestoid embryo in this condition has received the name of a cystic worm. The development of the scolices in such cystic entozoa is sometimes more, sometimes less, advanced.

I have already shown that the cestoid embryos, after leaving their eggs, must wander, in order to establish themselves in

fitting animals and become developed into agamozooids. If anything is to come of these wanderings, however—that is to say, if the cestoid embryos are to propagate, two main conditions must be fulfilled. In the first place, the localities chosen for lodgement must afford suitable nourishment; in the second place, the animal selected by the embryo as its home must afford an opportunity to the scolex developed within it, to reach the appointed intestinal canal of a vertebrate animal, either by active or passive emigration, in order to accomplish its sexual development and propagation. That the cestoid embryos should often go far astray in their wanderings, whereby these conditions are left unfulfilled, is easily conceivable; however, these strayed cestoid embryos do not perish, but notwithstanding the degeneration which they undergo retain sufficient tenacity of life to be capable of further development and propagation. Objections have been raised by some to the opinion I have just expressed, that strayed cestoid agamozooids may undergo dropsical degeneration; and it is urged, on the contrary, that the vesicles of these hydropic scolices are a necessary organ, a sort of reservoir of nutriment. In answer to this, I can only repeat what I have already said in another place,[1] in vindication of my views, viz., that I cannot see why one should deny the possibility of a degeneration in form among worms, since it is observed in the higher animals, where the modifications produced by climatic influences and change of food are at once admitted as "Races." If, in many of these races, an extraordinarily luxuriant growth of hair shoots out over the whole body, or on various parts of it; if the horns of certain races of ruminants have the property of lengthening, or even of doubling; if the ears of certain kinds of our domesticated animals become disproportionately long and drooping; if, in some races, local fatty degeneration takes place in the shape of a fatty tail or hump, why should not an accumulation of serous fluid in certain parts of the body, giving rise to a local dropsy, take place amongst the lower orders of animals, when these are exposed to the influences of an unusual mode of life?

The processes of degeneration to which the cestoid embryos are liable in their wanderings are of two different kinds; either the body of an embryo lengthens posteriorly into a solid caudal appendage, or else it becomes distended into a watery vesicle by

[1] 'Zeitschrift für Wiss. Zoologie,' Bd. iv, 1853, p. 407.

the accumulation of serous fluid. It may even happen that both these forms of degeneration attack the same embryo. For the better comprehension of these occurrences of excessive growth and of degeneration in the course of the development of the cestoid embryo, I will distinguish the part of the body of the embryo which becomes distended by the formation of the scolex, by the name of the *receptaculum scolicis.* Strictly speaking, this receptacle is no other than the embryo itself (see page 37, fig. 19**).

Whilst the scolex is becoming developed within the receptacle of a cestoid embryo, many and various changes of form may be going on in the embryo itself, *pari passu* with the vesicular change, and these have given occasion to the erection of the various genera of cystic *Entozoa.*

Those Tænioid embryos whose receptacle has become distended to sometimes a larger, sometimes a smaller vesicle, have been hitherto included in the cystic genus *Cysticercus.* If such a *Tænia* scolex extrudes itself from its vesicular receptacle, it is obvious that the posterior part of the scolex passes immediately into the vesicle, and the presence of such a caudal vesicle in the scolex of a *Tænia* has been raised into the generic character of the *Cysticerci* (figs. 24, 25). Exposed to certain external influences, the receptacle of a *Tænia* scolex becomes distended into a very large and spacious vesicle, from the inner surface of which, a number of *Tænia* scolices develop by budding; this form of cystic worm has been elevated into a genus, *Cœnurus.* Another kind of Tænioid embryo becomes metamorphosed into a vesicle of larger or smaller dimensions, from whose inner surface countless scolices pullulate; these, however, become detached, and lie freely within the cavity of the closed parental vesicle. Upon this form the genus *Echinococcus* has been founded.

Fig. 24.

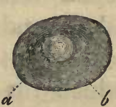
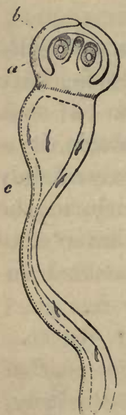


Fig. 25.

Fig. 24. *Cysticercus cellulosæ* from the human brain, of its natural size, and with a retracted anterior extremity. Fig. 25. The same *Cysticercus* extruded. *a.* The caudal vesicle of the Cysticercus, which is nothing but the *receptaculum scolicis* (or hinder end of a Tænioid embryo), distended into a vesicle by the accumulation of water. *b.* The retracted anterior end of the body of the Cysticercus contains the tænioid scolex developed by budding within the embryo. *c.* The transversely wrinkled anterior extremity of the Cysticercus. *d.* Its head and neck, which conjointly form the Tænioid scolex.

The changes of those cestoid embryos in which the receptacle grows out behind into a long, solid, caudal appendage, are very remarkable. The receptacle of the *Tænia* scolex which Stein observed in the meal-worms, developes such an appendage (page 38). I must remark here, that Stein considers the scolex receptacle as a cyst, and the caudal appendage as a part of it, which is certainly not correct, for if the tail does not appertain to the embryo, how could the six hooks have come to lie upon the upper surface of the tail, where, according to Stein's express assertion, he invariably saw them?

Fig. 26.



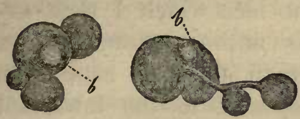
The *Piestocystis crispa,* which attains a length of from one to three inches, is nothing more than a *Tænia* scolex evolved from its receptacle, with a very long, ribbon-like, solid, caudal appendage.[1] In certain *Tetrarhynchi* the receptacle also becomes distended into a vesicle, and such forms of *Tetrarhynchi* were united by the older helminthologists into the genus *Anthocephalus.* From this genus Diesing separated, under the names of *Acanthorhynchus* and *Pterobothium,* those *Tetrarhynchus* scolices, the posterior end of whose receptacle is produced into a very long, unjointed, caudal appendage. As in these degenerations, the form and size of the vesicular dilatations of the receptacle, as well as the shape and length of its caudal appendage, are often dependent upon accidental external influences, the dissimilarity which the parts present in different individuals of one and the same species of scolex become readily intelligible. For this reason, such diagnostic characters of genera and species as are derived from the conformation of the vesicular enlargements and of the caudal appendages of the receptacle must be discarded on account of their uncertainty. Only on the form of the scolex (the so-called head of the sexually matured cestoids) is it possible to base constant generic and specific characters. A

Fig. 26. A *Tænia* scolex from the meal-worm retracted within its receptacle; partly after Stein. *a.* Head of the scolex. *b.* Receptaculum scolicis. *c.* Caudal appendage of this receptacle, on which lie scattered the six embryonic hooks.

[1] This animal was formerly described by Rudolphi as *Cysticercus crispus.* I have demonstrated, however, in the 'Zeitschrift für Wissenchaftliche Zoologie,' (Bd. ii, 1850, p 223), that this worm possesses no caudal vesicle.

striking proof of this is offered by the *Cysticercus cellulosæ*, of which the diagnosis invariably states, that it possesses a "vesica caudalis, elliptica, transversa." This form of caudal vesicle is, however, only found in such *Cysticerci* as are imbedded in the muscles of men and pigs; in individuals of the same species residing within the human brain, the caudal vesicle assumes the most various and irregular forms (figs. 24, 27, 28). Even in the *Tænia*-scolex observed by Stein,[1] the caudal appendage of the receptacle assumed the greatest variety of shapes.

Fig. 27. Fig. 28.



If attention had been earlier directed to these circumstances, the cystic *Entozoa* would not have been made into a separate order from the *Cestoidea*. The older naturalists and helminthologists took a far more just and unprejudiced view of the matter, when, from the similarity of the degenerated cystic scolices with the heads of certain *Cestoidea*, they divined the close connection of the two orders, and described the *Cystica* as *Tænia vesicularis, Tænia hydatigena, Tænia cellulosæ*. Even the dropsical condition of these cystic worms did not escape the eyes of the older naturalists, since already, in 1691, Tyson[2] described the *Cysticercus tenuicollis* as *Lumbricus hydropicus*.

But after Linnæus had animated naturalists with his spirit of arrangement, they worked with such good will and so exclusively, at the perfection and completion of his system, that for a long time it seemed to be thought enough if generic and specific names were given to newly discovered animals, and their due systematic place assigned. The inquiry into the natural history of these animals hence became quite a secondary consideration, and with such a one-sided study of animal forms, it could hardly fail to happen that not merely varieties, but also young states, larvæ, and even fragments of animals already known, should be described and systematically arranged as peculiar animals.[3]

Figs. 27, 28. Two *Cysticerci* rendered quite irregular by constriction of their vesicles; from the human brain, natural size. *b*. The retracted anterior edge of the scolex. In fig. 28 the constricted parts are produced into tubes.

[1] See 'Zeitschrift für Wiss. Zoologie,' Bd. iv, 1853, p. 207, and pl. x, figs. 12—14.

[2] 'Philosophical Transactions,' 1691, No. 193, p. 506, figs. 1—4.

[3] Ehrenberg's and Diesing's systematic works on *Infusoria* and *Entozoa*, testify that this faulty and one-sided method finds followers even now.

It is to the peculiarity in the form of the *Cysticercus fasciolaris* that we owe the recent recognition of the connection between the cystic and the cestoid worms. The similarity of the head of this *Cysticercus* with that of the *Tænia crassicollis* is so great and striking, that I can scarcely claim much merit for having been the first to entertain the idea which I thus expressed:[1] the *Cysticercus fasciolaris* is nothing more than a strayed or degenerated *Tænia,* which may, however, attain the normal form of a tape-worm if transported to the intestinal canal of a suitable animal. Both forms are so intimately related to each other in form and organization, that I am not surprised at Allen Thomson, of Glasgow, having recognised the agreement of the *Cysticercus fasciolaris* with the *Tænia crassicollis* without, as it seems, being aware of my researches and publications upon the subject.[2] The mutual affinities and relations of these two *Entozoa* are the more perceptible, because during the growth of the *Cysticercus fasciolaris* the joints of the future tape-worm are developed between the caudal vesicle and the head. These joints certainly remain narrow, and develop no sexual apparatus, but they give to the scolex, which in this stage of development always has the head extruded, such a characteristic appearance, that its identity with the *Tænia crassicollis* can only be denied by those who regard the caudal vesicle as the sole test of systematic position. If we examine the *Cysticercus fasciolaris* or altered *Tænia crassicollis,* more narrowly, we shall perceive in this tape-worm the same peculiarity which occurs in the various other cestoids, for instance, in *Triænophorus nodulosus, Tænia longicollis* and *ocellata,* viz., that the body of the tape-worm grows from the back part of the head and neck of the scolex, even before this has reached the intestine of the vertebrate animal adapted to its sexual development (see page 32). There is, however, an additional departure from the ordinary course in the *Tænia crassicollis,* that during the development of its scolex its receptacle undergoes a dropsical degeneration.

As the *Cysticercus fasciolaris,* which is found always encysted, in the livers of various rodents—most commonly those of rats and mice—is often met with several inches long, the caudal vesicle terminating the elongated body of such individuals, which

[1] Compare my article "Parasiten," l. c., pp. 650, 676.

[2] 'Zeitschrift für Wiss. Zoologie,' Bd. iii, 1851, p. 97.

never grows in the same proportion, is very minute, which seems to render probable the notion that the caudal vesicle of these cestoids has not originally been a scolex receptacle, but is rather the hinder end of the tape-worm in a diseased and dropsical state. Such dropsical enlargements are undoubtedly found occasionally in single joints of the *Cestoidea;* but if attention is paid to the gradual development of the tænioid *Cysticercus fasciolaris* it will be seen that its caudal vesicle is at an early period a true *receptaculum scolicis.* I have before me many examples of the *Cysticercus fasciolaris* which present the most various stages of development, the oldest being from five to seven inches long, whilst the youngest were no more than from one to four lines. Amongst the older individuals the long body is distinctly jointed; in the younger the short body merely presents very close transverse wrinkles as indications of the future joints. At all these different ages, the caudal vesicle appears to have about the same size, and indeed in the older individuals is even somewhat smaller. The youngest individuals, of one and one and a half lines long, have no body at all; in these the head and neck of the scolex only project, in the slightest degree, from the vesicular receptacle, whilst these parts, in the smallest individuals, which possess a perfectly rounded vesicle, are still, as I have most distinctly convinced myself, concealed in the receptacle. If one were carefully to inspect the livers of many different species of murine rodents, one would certainly come upon still younger forms of development of the scolex of *Tænia crassicollis;* one might even be so fortunate as to discover the embryo hooks on the external surface of the receptacle of the developing scolex, although the discovery of these six hooks of the cestoid embryo, on account of their excessively small size, is a very difficult task. In the *Cysticercus pisiformis,* which, always encysted, infests the livers of hares and rabbits, I have succeeded in meeting with the scolex receptacle, in a very early period of development, with a diameter of half a line. The internal gemmation had just begun, the four suckers of the future scolex were scarcely sketched out, and the still soft apices of the circlet of hooks were only just in process of formation (see fig. 33, *d, e*), but I sought in vain for the six embryo-hooks on the external surface of the receptacle. In pursuing these inquiries, however, a very interesting phenomenon was presented by the livers of some wild rabbits of this neighbour-

hood. Besides containing many very small scolices of *Cysticercus pisiformis* just developing, there were a number of short, pale-yellow lines crossing each other in all directions, which, upon microscopical inspection, did not seem to be sharply defined, and appeared to consist of a granular substance. I suspect that this substance was the product of an exudative process, occasioned by the creeping about of the immigrated *Tænia*-embryos in the substance of the liver; probably it would be gradually reabsorbed when, in course of their development and metamorphosis, these embryos had become converted into the dropsical receptacles of *Cysticercus pisiformis*.

CHAPTER IV.

ON THE ORIGIN OF THE CESTOID AND CYSTIC ENTOZOA.

THE extraordinary likeness of the *Cysticercus fasciolaris* of rats and mice with the *Tænia crassicollis* of cats, and the fact that the above rodents are the principal food of cats, and that, moreover, the joints of the *Cysticercus fasciolaris* enclosed in the cysts in the livers of rats and mice are never sexually developed, inclined me to believe that this sexless *Cysticercus fasciolaris* would be changed into a sexually matured *Tænia crassicollis*, as soon as the animal it lodged in should be devoured by a cat. For, under these circumstances, the liver of the devoured rodent would be digested in the cat's stomach, and the cystic worm, freed from its cyst, would be transplanted to a place where, after casting off its caudal vesicle, it might, as a *Tænia crassicollis*, attain to sexual maturity in the intestine of the cat. Fully as I was persuaded of the possibility of such a transformation of the *Cysticercus fasciolaris* into *Tænia crassicollis*, yet I could hardly conceive that the other species of *Cysticercus*, in which no jointed body was developed between the head and caudal vesicle of the scolex, could become *Tæniæ;* and this appeared the more unlikely, as I had often found cysts that had perished, in which the *Cysticerci* they contained were dead, and lay shrunk and buried amidst inorganic calcareous deposits. Such a calcareous degeneration of the cysts[1] must assuredly render the cestoid scolices incapable of propagation; still all do not meet with this fate, for under favorable circumstances they can, even in spite of their dropsical receptacle, subserve the multiplication of sexual cestoids; that is to say, when they are transported into the intestinal canal of animals fitted for the development of *Proglottides*.

That the cystic *Entozoa* can thus become changed into sexual

[1] I have more particularly described this process in the 'Zeitscrift für Wissenschaftliche Zoologie,' Bd. ii, 1850, p. 225.

cestoids, has been proved by Küchenmeister, of Zittau, by experiments first made by him, and published in various medical and natural history periodicals.[1] It was a very happy thought of his to institute experiments of feeding animals with *Cysticerci*. I have repeated and extended these feeding experiments, and can substantiate what Küchenmeister was the first to make known, viz., *that certain cystic Entozoa become Tæniæ in the intestinal canal of dogs.*

The chief condition for the success of these experiments is, that the cystic worms should be lively, or at least capable of being revived when administered; to which end they must be made use of directly, or at the most a few hours after, the death of those animals which yield them. As long as the organs of the mammals in which these parasites abound remain warm, one may be sure that the worms are still living; with the cooling of the infested organism, they become gradually languid, and at last seem quite dead, but from this state they can be restored to life, even after the lapse of several hours, by the application of warmth. When I was not certain whether the cystic worms I was using for my feeding experiments were still living or not, I threw them into luke-warm water, and then only made use of those individuals which had by this means been re-animated.

To produce tænioid worms out of cystic worms, I caused the latter to migrate passively into the intestinal canal of puppies by feeding these with them. Puppies of about a week or two old were most suitable. They lapped up the milk in which the cystic worms were mixed very readily; those which exhibited no particular appetite at the moment had their jaws held open and the milk poured down their throats, so that the swallowing of the worms was secured. At first I made use of cats, rabbits, and Guinea-pigs, also, for these experiments; but they afforded me no satisfactory results.[2] But the dog, as I shall presently show, is by his mode of life naturally obnoxious to those cystic worms with which I experimented, and hence the experiments with puppies necessarily succeeded.

[1] The first notice is given in Günsburg's 'Zeitschrift für Klinische Vorträge,' 1851, p. 240.

[2] All the feeding experiments cited in the following pages were carried on in the year 1852.

1. EXPERIMENTS OF FEEDING WITH CYSTICERCUS PISIFORMIS.

The cystic entozoon, known by the name of *Cysticercus pisiformis*, is a very common inhabitant of the liver and peritoneum of hares and rabbits. Cysts as large as a hazel-nut are frequently disseminated completely through the substance of the liver of hares, and these cysts are not unfrequently found hanging down like bunches of grapes from the external surface of the liver; in rabbits the great omentum and the mesentery are generally full of these cysts. Commonly such a cyst only contains a single *Cysticercus pisiformis*; but two are also sometimes enclosed in a common cyst. In Breslau, the rabbits which were sold in the markets in the spring months of 1852 were almost invariably infested by this *Cysticercus*, whence I made use of them at the Physiological Institution in that place for my feeding experiments. The results of these experiments were published in the inaugural dissertation[1] of my pupil, Dr. Lewald, who took a very active share in them; subsequently I gave some account of them myself in the 'Zeitschift für Wissenschaftliche Zoologie,' Bd. iv, 1853. The number of *Cysticerci* which I administered at once in these experiments was various, seven, twenty, forty, and sixty. In all cases, the *Cysticerci* were left enclosed within their cysts, and in these experiments, as in all subsequent ones, I wrote down in my journal, the precise time of feeding, the number of the cystic worms made use of, and the dogs fed with them, subjecting these last, after feeding, to strict watching and careful attention.

Of experiments tried with *Cysticercus pisiformis* upon ten dogs, the following are the results, which I repeat from the report I made in my essay in the Zeitschift cited above. When the encysted *Cysticerci* are devoured, it is the cysts which are first attacked by the gastric juice in the dog's stomach, and then the caudal vesicle is consumed; but not, however, the remaining part of the *Cysticercus*, so that of the whole *Cysticercus pisiformis* nothing more is left than the whitish round body which was enclosed in the caudal vesicle, and which consists of the head and neck of the animal involuted within its body, or, in other words,

[1] This dissertation appeared at Berlin in 1852, under the title 'De Cysticercorum in Tænias metamorphosi pascendi experimentis in instituto physiologico Vratislavensi administratis illustrata.'

is the scolex. Even before the caudal vesicle is digested, it frequently shrinks and collapses, its thin contents being discharged, probably by exosmosis, into the thicker fluid of the stomach. Accompanying the latter, the remaining portions of the *Cysticerci*, viz., the tailless bodies with their involuted neck and head, pass into the duodenum through the pylorus. Having reached the duodenum, the heads and necks of the *Cysticerci* are extruded, in order that they may find places of attachment by means of their suckers and hooks, between the villi of the intestine, where they may await the growth and further development of the other parts of their body.

During the first hours of their sojourn in the small intestine, these outstretched tailless *Cysticerci* (scolices) often present a bloated œdematous appearance; but by degrees the body becomes thinner, probably parting by exosmosis with its superabundance of fluid, and in this manner establishing an equilibrium with the more or less viscous chyle. In all these *Cysticerci* the posterior end is clearly the place where, at an earlier period, the caudal vesicle was attached, as is evinced by a sort of scar, like a notch or incision, from which at first very delicate flakes of membrane depend, the remains of the digested caudal vesicle. Already, after a day or two, the worms begin to exhibit a growth, in which only the body takes part, the neck and head being already fully developed, whilst the worms were still within the peritoneum of the rabbits. Whilst the bodies of the worms, as yet unjointed, and only provided with very close transverse wrinkles, increase in length, the transverse wrinkles also multiply; and if the growth of the body goes on uninterruptedly, the transverse wrinkles, after a day or two, change by degrees into distinctly marked articulations; the joints, which are at first very short, lengthen, and there appears either on the one lateral border or on the other a kind of papillose elevation, which afterwards becomes the aperture of the sexual organs. In this condition the ingested worms have exactly the appearance of a *Tænia*, and only betray their origin by that scar on the terminal joint of their body, of which I have already spoken. After remaining twenty-five days in the dog's intestine they have become *Tæniæ*, of from ten to twelve inches long. The growth of these *Tæniæ* goes on without intermission, the posterior joints increasing in size, and the reproductive organs in the interior developing more and more, whilst at the hinder limit of the neck fresh joints are continually

produced from the transversely wrinkled anterior part of the body. In three months these *Tæniæ* attain the length of from twenty to thirty inches and more.[1] In such *Tæniæ* the posterior joints seem to have reached their full sexual development. In some of these tape-worms the last joints become cast off, a proof of their having attained their sexual maturity. The eggs contained in the fully formed joints are perfectly developed, and contain an embryo, furnished, in the usual manner, with six moveable hooks.

After having thus obtained sexually developed *Tæniæ,* that is to say scolices with sexually matured *proglottides,* from the *Cysticercus pisiformis,* I was enabled to decide to which species of tape-worm these scolices, as the head end, and the *proglottides,* as joints, belonged, and I recognised in them the *Tænia serrata,* which had long been known to infest the intestine of dogs. The form of the head, the number, shape, and arrangement of the hooks encircling the head, the construction of the joints, and of the sexual organs within them, the form of the developed eggs, all persuaded me that I had educed the *Tænia serrata* out of the *Cysticercus pisiformis.*

Perhaps some of my readers may doubt the conclusion I drew from the above-mentioned experiments, and may object—How could I be sure that the dogs which I fed with the *Cysticerci* might not have come by the tape-worms known as *Tænia serrata* in some other manner? This objection occurred to myself, and all the more strongly since in searching the intestinal canal of dogs fed with *Cysticercus pisiformis* I often met with thread-worms and tape-worms of another kind (*Tænia cucumerina*), among individuals of *Tænia serrata.* So that the question naturally arose whether, in the same way as individuals of the dog's thread-worm (*Ascaris marginata*), and the ordinary dog's tape-worm (*Tænia cucumerina*), had found their way into the intestine of the dogs experimented upon, so these individuals of the other rarer tape-worm (*Tænia serrata*) might not also have arrived there without any assistance of mine. I can, however, bring forward the following demonstrative evidence to substantiate my assertion, that the individuals of *Tænia serrata* which I discovered in the course of these experiments were really produced from *Cysticercus pisiformis.* I have repeatedly searched the

[1] With regard to these different stages of development, see the figures in Lewald's 'Dissertation,' cited above.

intestines of puppies of the same litter as those I had used in my other experiments, and have never found *Tænia serrata* in them; but, on the other hand, I have very commonly met with *Ascaris marginata* and *Tænia cucumerina.* I must here remark that I only made use of parlour and house dogs for my purpose, and it is in these that both the above-named parasites ordinarily appear, the *Tænia serrata* more commonly infesting hunting dogs. Still further confirmation of my view is afforded by the important circumstance that after feeding the dogs with *Cysticercus pisiformis,* the number of tape-worms of the species *Tænia serrata,* which were found more or less developed in their digestive canal, agreed exactly with the number of *Cysticerci* I had given. Another circumstance worthy of observation, and strongly confirmatory of my view, is, that the size and the condition of development of the *Tænia serrata* in the intestine of the dogs that had been fed with *Cysticerci,* exactly corresponded with the time that had elapsed since the period of feeding.

2. EXPERIMENTS OF FEEDING WITH CYSTICERCUS TENUICOLLIS.

The slender-necked *Cysticercus* is very commonly met with in the viscera of our fat cattle; as regards its caudal vesicle it is the largest of all the *Cysticerci,* for this often attains to the size of a fist, whilst its head never exceeds that of an ordinary *Cysticercus* in circumference. As these *Cysticerci* were generally brought to me enclosed in their cysts, and as the walls of the cysts were penetrated by a great deal of fat, I always disengaged the tape-worms from their investments before I fed the dogs with them.

First experiment.—In the beginning of May, 1852, I made my first preliminary experiment of feeding with the *Cysticercus tenuicollis* upon a young hound ten weeks old, to whom I gave six *Cysticerci* within four days. A few days afterwards I found, in this dog's intestine, only the head ends of the ingested worms. They were from one to one and a quarter line in length, and consisted of the head and solid neck of the former cystic worm, of which the scolex had alone escaped digestion. In order to ensure the greater success of my experiments, I each time cut off beforehand the voluminous caudal vesicle of the selected tape-worms, and only fed the dog with those which had the neck and head involuted in the cylindrical and hollow body.

Second experiment.—On the 11th May, a second young hound

was fed with twenty-one cystic worms. On the 12th May, he had five, and on the 14th, three more, so that this dog altogether swallowed twenty-nine Cysticerci without their caudal vesicles. On examining the dog on the 17th May, seventeen scolices were found in his small intestine, of which the smallest was from three quarters to one line in length, and the largest two lines.

Third experiment.—A young poodle swallowed, on the 18th June, twelve *Cysticerci*, of which, on the 23d of June, eleven were found as scolices, from one to two and a half lines in length, in the small intestine of the dead animal.

It was then the body of the *Cysticercus* that had perished by digestion, for the short thick body of these scolices was no other than the neck of the *Cysticercus*. It showed no trace of transverse wrinkles, and at its posterior end appeared to be cut off transversely or obliquely, with a sort of hollow scar in the middle, denoting the place where the hollow cylindrical body of the *Cysticercus* had been detached in the dog's stomach.

In uninjured individuals of *Cysticercus tenuicollis* one can easily recognise that portion of the body which, in the small intestine of the dog, becomes the scolex, by putting the uninjured worms into lukewarm water. The worms seem to like the warmth, which corresponds with that of the mammals they infest, moving about in the most lively manner, and stretching out their tubular body (previously contracted into a short, transversely wrinkled, milk-white knot), with the head seated at its extremity on a short, slender, and solid neck, for a long distance. This thin neck appears to be sharply separated from the body of the worm, and easily permits the line of demarcation to be seen, where, at a later period, the head and neck become detached as the scolex.[1]

Fourth experiment.—A young mongrel pug-dog received, at various intervals, two-and-twenty cystic worms; namely, on the 11th July, six; on the 14th July, fourteen; and on the 17th, two. The examination of this dog when killed, on the 5th August, proved that out of these two-and-twenty worms nineteen individuals had passed as scolices out of the stomach into the small intestine, and that their seventeen to three-and-twenty days' sojourn had caused a remarkable growth in their abdominal

[1] Amongst the various figures of the *Cysticercus tenuicollis*, that given by Pallas, (see his 'Miscellanea Zoologica,' 1766, p. 167, Tab. xii, fig. 10; or 'Stralsundisches Magazin,' Bd. i, 1767, p. 69, Taf. ii, fig. 10), exhibits the head and neck marked off from the body of the worm as the future scolex, very distinctly.

end which gave them the appearance of tape-worms. The length of these tape-worms varied with the difference of age from four lines to an inch and three quarters. The shortest individuals evidently proceeded from those scolices which had been only seventeen days in the small intestine of the dog.

In the individuals of four lines long one could trace very close transverse wrinkles gradually appearing behind the neck, always more closely defined towards the posterior part, and denoting, where they became wider apart, the future joints of this portion of the body. The individuals of eight lines long, already possessed a clearly jointed hinder end, the joints increasing in number with the length of the individual. In all the individuals the scar I have mentioned was to be seen on the hinder extremity of the body, or on its last joint. This last joint with the scar, moreover, always appeared smaller and more slender than the preceding ones, from which it follows that it is in that part of the scolex which is situated between the posterior end and the neck that the growth and articulation of the tape-worm takes place. The sexual apparatus was not perceptible either in the interior or on the exterior of the joints of these tape-worms of from seventeen to twenty-three days old.

Fifth experiment.—On the 19th July, eight *Cysticerci* were given to a sporting dog, and on the following day six-and-twenty, to which were added four more on the 22d; so that within four days this dog had devoured altogether eight-and-thirty *Cysticerci tenuicolles*. The small intestine of this dog, which was inspected on the 20th August, afforded thirty-two *Tæniæ* in very different stages of development. In regard to their length, a great difference already prevailed; in the smallest individuals the diameter varied from four lines and a half to one inch and a half, whilst the longest extended from five to ten and a half inches. The consequence of this was that although from nine-and-twenty to two-and-thirty days had elapsed since the *Cysticerci* had been administered, their scolices had most unequally developed, some of them being greatly behindhand in point of growth. I observed the same thing in several other experiments. The reason of this unequal development of the tape-worms may lie partly in the different individuality of the *Cysticerci*, partly in that of the dogs fed with them. In the longest individuals that I obtained from this experiment the development of the joints was, moreover, most advanced; although these joints were always

wider than they were long, still the development of the sexual apparatus, manifested externally by the presence of irregularly alternating sexual apertures on one side or the other, had already commenced within them. In a few of the most developed posterior joints of one individual, I could perceive roundish hard-shelled eggs, which contained the characteristic embryo with six hooks, and in regard to shape, size, number, and arrangement of the investments of the egg, exactly resembled the eggs of the *Tænia serrata.* I must also remark, that in the larger individuals the developed joints were marked, on the upper surface, with transverse wrinkles, which gave their lateral edges a wavy appearance, and that the slightly prominent posterior edge of many of these joints seemed to be faintly and irregularly puckered. Some of the largest individuals had already cast off their hindermost joints; in others, the last "scarred" joint was peculiarly altered; it was much enlarged, but had at the same time taken quite an irregular shape, with blunt projecting angles at the sides; the sexual aperture at the side, and the small scar on the posterior edge, alone betokening its true nature.

Sixth experiment.—A mongrel of poodle and spaniel, which had devoured five *Cysticerci* on the 7th June, and twelve on the 29th June, was killed on the 25th July, that is eight-and-forty days after the first meal, and six-and-twenty after the second. Out of the seventeen *Cysticerci* administered, fifteen were again discovered as sexually matured tape-worms; the smallest were from four to nine inches long, the largest from fourteen to twenty-six inches. In these last the posterior joints appeared already to be longer than they were broad. In other individuals the less elongated posterior joints had a squarish or transversely elongated shape, and upon their exterior surface showed the above-mentioned transverse wrinkles. The hindmost joints were cast off in some of the larger individuals, whilst the rest still possessed the original posterior joint, which was remarkably grown, not being in the least degree inferior in size to the other posterior joints, from which, however, it was essentially distinguished by the small scar on its posterior rounded edge.

Seventh experiment.—From the 21st May to the 5th June, an interval of sixteen days, thirty-one thin-necked *Cysticerci* were administered to a young fox. On the 13th June he was killed and examined; but there was not a trace in his intestines of the *Cysticerci* he had eaten, either in the shape of scolices or of tape-

worms, from which we may venture to conclude that the stomach of the fox had perfectly digested the *Cysticerci* with which he was fed.

I now took much pains to determine the species of these tape-worms obtained from *Cysticercus tenuicollis,* and was astonished to discover that they had all the characteristic features of *Tænia serrata.* The form of the eggs of the tape-worms obtained from *Cysticercus tenuicollis* had first drawn my attention to the *Tænia serrata,* whose eggs, in form and in the number of their investments, completely coincided with the eggs of the tape-worms I had obtained. Comparing the head end of the latter with that of the *Tænia serrata,* I could neither in the outline, nor in the suckers, nor in the hooks of the double circlet, perceive any difference between these *Tæniæ ;* even the fully developed, as well as the less developed joints of these tape-worms, with their transverse wrinkles, reminding one of *Tænia serrata.*

In respect to the negative result of the seventh experiment, I must leave the question open, whether it is not possible that the intestine of the fox is unfit to afford a favorable nidus for the development of the scolex of the *Cysticercus tenuicollis.*

3. EXPERIMENTS OF FEEDING WITH CYSTICERCUS CELLULOSÆ.

The *Cysticercus cellulosæ* occurs, as is well known, in such numbers in the flesh of our domestic pigs, that from a single muscle of one of these animals hundreds of these cystic worms may sometimes be collected; and even in the flesh and intestines of man, its occurrence is not an unusual phenomenon. For the last reason I was exceedingly anxious to try the result of feeding with *Cysticercus cellulosæ,* in order that I might discover from which kind of tape-worm these *Cysticerci* are produced.

First experiment.—A young dog was fed, on the 22d May, with forty-four *Cysticerci ;* on the 24th May, fourteen more were given him, and on the following day, five-and-thirty. Before the worms were given, they were taken out of their cysts. The dog was killed on the 3d July, which was thirty-nine days after the last feeding, and forty-two days after the first. Only four tape-worms of two inches in length were found in this dog's small intestine. From their appearance, they were evidently the product of the *Cysticerci* which the dog had swallowed.

Second experiment.—Having procured two *Cysticerci* from a

human brain, which, when put into luke-warm water thirty-six hours after the death of the subject, still moved, I would not, few as they were, allow the opportunity to pass of making an experiment of feeding with them; nevertheless the young dog to whom I administered them on the 22d May, and who was killed on the 14th June, that is twenty-three days after receiving them, showed not the slightest trace of a tape-worm or scolex.

Third experiment.—On the 18th June, a young poodle swallowed two-and-forty *Cysticerci* from the pig, deprived of their cysts. The examination of this dog, on the 4th August, fifty-one days after feeding, showed eight tape-worms of different lengths. The smallest individual measured one inch and a quarter, a few others measured five and a half to seventeen and a quarter inches, a larger individual was twenty-five and a quarter inches long, whilst the three largest individuals had attained the length of fifty-one inches. Notwithstanding the length which the worms had attained, and the great number of their joints, I could discover no perfectly developed eggs in any of the latter.

Fourth experiment.—To a young pug-dog two and thirty *Cysterci*, without cysts, were administered on the 11th July, and five-and-forty on the 17th. On the 21st July the dog was killed. On inspecting the small intestine forty-six scolices were found, of which the shortest measured one line, the longest six. All bore the characteristic scar on their posterior extremities. The smallest individuals consisted of nothing else than the head and neck of the *Cysticercus cellulosæ*. The remaining and somewhat longer individuals had a transversely wrinkled body, which as yet bore no traces of joints.

Fifth experiment.—On the 8th August, a young setter was fed with five-and-forty *Cysticerci*, which were still in their cysts and enclosed in flesh. On the 21st August, this dog was likewise killed. In his small intestine only a few tape-worms in course of development, of three fourths of an inch in length, were found.

I must here remark that the dogs I made use of for the second, fourth, and fifth experiments were troubled with the distemper, a thing of common occurrence amongst young dogs, and that the disease had probably had an injurious effect upon the development of the tape-worms. Notwithstanding that these experiments of feeding the dogs with *Cysticercus cellulosæ* afforded no such completely favorable results as the foregoing series, they nevertheless

went far enough to prove that the *Cysticercus cellulosæ* may also, in the intestine of the dog, become developed into a *Tænia.*

The few *Tæniæ* which were obtained from these *Cysticerci* were, moreover, a source of great perplexity to me, for when I attempted to define the species to which they belonged, I was doubtful whether to consider them as appertaining to the *Tænia serrata* or to the *Tænia solium.* The head and perfectly developed joints accorded with either species, only the neck was longer and more slender than that of *Tænia serrata,* so that I was inclined to regard them as *Tænia solium.* Owing to the resemblance of these tape-worms, *Tænia serrata* and *solium,* to one another, I was induced to submit the specimens of *Tænia solium* in my collection to a more searching examination, and to compare them with the examples of the *Tænia serrata* taken out of the dogs. To my no small astonishment I found individuals amongst *Tæniæ* which had been taken from the human subject that were not to be distinguished from *Tænia serrata.* They had the short broad joints with transversely wrinkled integument and undulating posterior edge, just like *Tænia serrata;* the head, too, was formed exactly like that of the latter, though the neck was more elongated. Besides these, there were a few feeble individuals amongst them, which fully corresponded with some of the tape-worms produced from *Cysticercus pisiformis;* and the eggs of the *Tænia solium* were not distinguishable from those of the *Tænia serrata,* so that I was forced to conclude that *Tænia solium* and *Tænia serrata* were identical. In order to obtain a still clearer insight into the matter, I further compared the heads with their apparatus of hooks of *Cysticercus pisiformis, longicollis,* and *cellulosæ* with one another, and in these also I could find no difference.

With regard to the length of the neck, and the circumference and contour of the joints, though there are, as I have already partly shown, discoverable differences, they are not sufficiently marked to rank as distinctive characters of two species of tape-worms, and I must therefore maintain that *Tænia solium* and *Tænia serrata* belong to one and the same species; that they are the extreme forms of a single species, connected by a series of transitional forms.

4. EXPERIMENTS ON FEEDING WITH CŒNURUS CEREBRALIS.

In order to make as sure as possible with these experiments, I took dogs, which I had selected for feeding, into the country with me, to the very place where there were sheep affected by the staggers, and let them swallow the cystic worms fresh from the sheep affected with the disease, that had just been killed. If the parental vesicle were small, and only covered by a few clusters of scolices, they were left in connection with it; but if the parental vesicle had attained a considerable size, it was divided and given in portions to several dogs. (Fig. 29.)

Fig. 29.

Fig. 30.

Fig. 31.

Fig. 32.

Fig. 33.

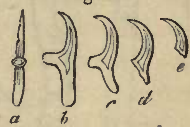


Fig. 29. A portion of the parental vesicle with an attached colony of involuted scolices of *Cœnurus cerebralis* from the brain of a calf, seen from the external surface, of the natural size. Each of the separate rounded corpuscles corresponds with a scolex developing or developed by internal budding: *a*, a complete involuted scolex; *b*, a still imperfect involuted scolex; *c*, many scolices commencing their development.

Fig. 30. A bit of the parental vesicle with a colony of everted scolices of *Cœnurus cerebralis* from the brain of a calf, seen from the external surface, and of the natural size.

Fig. 31. An everted scolex detached from its parental vesicle (fig. 30), and magnified to the same extent as the succeeding figures. *a*. The protruded double circlet of hooks on the cephalic extremity. *b*. One of the four cephalic suckers. *c*. Fragment of the detached parental vesicle.

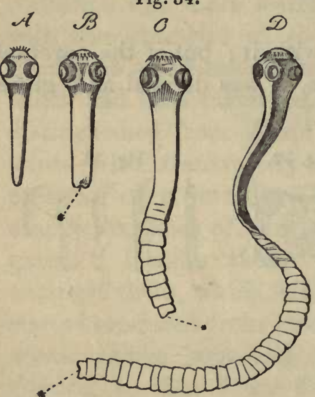
Fig. 32. The head of a similar scolex seen from above; the double circlet of hooks surrounded by the four suckers is seen in the middle.

Fig. 33. Various hooks from the double circlet of the scolices of *Cœnurus cerebralis*. *a*. A long hook of the inferior circlet seen from below. *b*. The same from the side. *c*. A short hook of the lower circlet also viewed laterally. *d*, *e*. Two not yet fully developed and soft hooks from the young buds, fig. 29 *c*.

First experiment.—On the 29th of May, a young dog was made to swallow a cyst with nearly a hundred scolices. He was killed on the 3d of June, that is, five days afterwards, and sixty-five free and everted scolices were found in the small intestines. Their length was from half a line to one and three quarters; they showed no trace of joints or transverse folds, and each exhibited on the posterior end of the body a small kind of cicatrix-like indentation, which plainly denoted the spot where the scolex had separated from the parental vesicle. (Fig. 34, *A*, *B*.)

Second experiment. — On the 6th of June, a young dog swallowed a large *Cœnurus*-vesicle, which was covered with several clusters of scolices. When, on the 26th July, the dog's small intestine was examined, it afforded an enormous number of tape-worms; I counted six hundred and forty individuals in the most various stages of development and growth. The longest, with its many joints, measured twenty-three inches; the shortest, having a length of two lines, were still unjointed, and yet perfectly resembled scolices. In all, the scar on the last joint, or on the unjointed posterior end of the body was not to be mistaken. (Fig. 34 and 35*.)

Fig. 34.

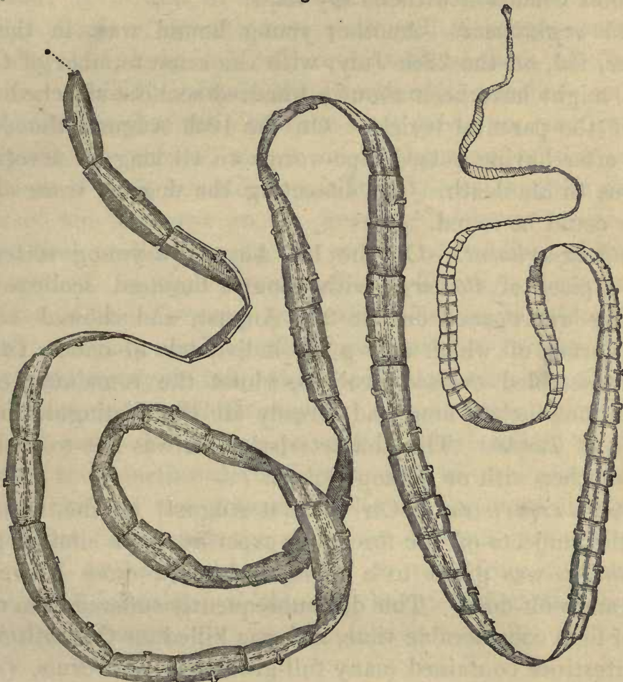


Third experiment.—On the 28th July a young terrier was fed with part of a large *Cœnurus*, and was killed on the 5th August, after a lapse of thirty-eight days. In his intestine there were seventy-one tape-worms variously developed. Three of the least developed individuals were from one and a half to two lines long, and appeared to resemble a scolex most completely, their smooth posterior end being devoid of joints;

Fig. 34. Different tæniæ developed in the intestine of the dog, from the scolices of *Cœnurus cerebralis*. *A.* A scolex one inch and three quarters long, with smooth and protruded body, viewed from the edge. *B.* The same scolex seen from the surface. *C.* A scolex three lines long; the articulation is beginning at the lower extremity. *D.* A still longer and more developed scolex, at whose hinder extremity the formation of proglottides has taken place to a great extent. * Scar, or place by which these *tæniæ* were fixed as scolices to the parental vesicle.

seven others were from four to six lines long, and showed a commencing articulation. A few worms of six lines in length appeared already distinctly jointed. Amongst the remaining specimens that had become fully developed into *Tæniæ,* several had attained the length of from sixteen to twenty-six inches. (Fig. 35). In the longest individuals the development of the

Fig. 35.



eggs was completed, in several shorter ones the characteristic scar on the last joint was wanting, and from the posterior edge of the last transversely truncated joint one could plainly perceive that these *Tæniæ* had already cast off matured joints (*proglottides*), and indeed it so happened that the dog had passed tape-worm joints with his fæces several days before his death.

Fourth experiment.—On the same day with the last mentioned

Fig. 35. A *Tænia serrata*, produced from a scolex of *Cœnurus cerebralis* in a dog's intestine, in thirty-eight days; natural size. The hindermost joints are fully formed proglottides. At the posterior extremity of the last joint the scar (*) clearly indicates that no proglottis has yet detached itself from this tape-worm.

dog, a young hound devoured a similar allowance of *Cœnurus*. He was killed on the 6th August, a day later than the other one. On searching his small intestines eighty-six worms were discovered, of which the majority had grown into jointed *Tæniæ* of three to ten inches in length, whilst several individuals of from four to five lines long only showed faint signs of the transverse wrinkling, and a few of from one to two lines long were still in the scolex condition without any folds.

Fifth experiment.—Another young hound was, in the same manner, fed, on the 28th July, with the same number of *Cœnuri*. There might have been about a hundred scolices attached to the coat of the parental vesicle. On the 10th August, the dog was killed after having passed tape-worms an ell long for several days previous to his death. On dissecting the dog no trace of tape-worms could be found.

Sixth experiment.—On the 1st August, a young setter swallowed a piece of *Cœnurus* with about a hundred scolices on it. The dog was opened on the 23d August, and showed seventy-three worms, of which only a few individuals of one to two lines long, resembled everted scolices, whilst the remaining ones of one to four inches long had already all the distinguishing characters of *Tæniæ*. The characteristic scar was not to be seen in any, whether with or without joints.

Seventh experiment.—On the 1st August, at the same time with the subjects of the foregoing experiments, a similar portion of *Cœnurus* was given to a mongrel-dog, (a cross between the setter and wolf-dog). This dog subsequently suffered from the distemper for a considerable time, and was killed on the 25th August. His intestines contained many full-grown thread-worms, (*Ascaris marginata*), and a few scolices of *Tænia cucumerina*, but no trace of worms that should have resulted from the feeding with *Cœnurus cerebralis*. The distemper had probably occasioned the failure of this experiment.

For the rest, the determination of the *Tæniæ* which I had obtained from these experiments of feeding with *Cœnurus cerebralis* was not difficult, the characters of the *Tænia serrata* being, in all of them, clearly and sharply marked.

It must have been remarked that in the third and fourth experiments (in which the scolices were retained in the dogs' intestines an exactly similar period of time), the *Tæniæ* in the one dog were twenty-two inches long, whilst those in the other

dog were only ten inches. This unequal development of the *Tæniæ* within the same period of time is probably to be accounted for by some special peculiarities of the circumstances into which, in these cases, the scolices of the *Cœnurus cerebralis* had been conveyed.

There is yet another remarkable phenomenon which was brought to light by the experiments on feeding with *Cœnurus cerebralis.* It is that in each separate case, worms, of a very dissimilar stage of growth were produced, although every individual dog had been fed only once with scolices of *Cœnurus cerebralis.* This diversity in the growth of the scolices conveyed at the same period of time into the same intestine, may, perhaps, originate in the various stages of development of the scolices at the time of their introduction. It is known that the parental vesicles of the *Cœnurus* go on growing without intermission, and that fresh scolices are, by the process of budding, continually springing forth on their inner surface. Through these peculiar conditions of the *Cœnurus cerebralis,* older scolices long since perfected, and only awaiting the opportunity of further development, were conveyed into the dogs' stomachs, together with younger ones, some of them only just formed, some, again, not yet fully developed. From this point the older scolices proceeded rapidly to their further development, and to the generation of *proglottides,* whilst the younger scolices grew more slowly, and the youngest forms, whose gemmation was not yet quite completed, were, probably, incompetent to pass from the stomach into the small intestines of the dog, but yielded to the digestive powers of the former.

Experiments on feeding with Echinococcus veterinorum.

The *Echinococcus veterinorum,* which is of such common occurrence in the liver and lungs of our domestic cattle, does not, probably, differ specifically from the *Echinococcus hominis,* whose parent vesicle often attains such an enormous size in the most widely different viscera of man, and by its growth so obliterates the substance of the organs round about it, as to bring about the death of its host. The experiments of feeding with these worms which I made on twelve young dogs and a young fox, I have already fully described.[1] For each experiment

[1] See the 'Zeitschrift für Wiss. Zoologie,' Bd. iv, 1853, p. 409, Taf. xvi, A, fig. 1—9.

the contents of a fruitful *Echinococcus*-vesicle were employed. That is to say, free scolices developed by gemmation were taken out of the *Echinococcus*-vesicle, mixed with luke-warm milk, and poured down the dogs' throats; the latter, after having in this manner been made to swallow a considerable quantity of the young of the *Echinococcus,* had some pure luke-warm milk given to them, which they licked up with avidity, so that these continued acts of deglutition made sure of the small *Echinococcus*-larvæ or scolices being washed into the dogs' stomachs.

The examination of these dogs after death proved, that the scolices of the *Echinococcus veterinorum,* when conveyed into the dog's digestive canal, do not perish, but, under certain favorable circumstances, develop into proper sexually matured tape-worms, possessing only a couple of joints. After the feeding, they passed without obstruction from the stomach into the small intestine of the dogs, where, in proportion to the number of scolices administered, they were found in immense numbers fully extruded from their receptacle, whilst, when in the interior of the parent vesicle, they are almost always to be found retracted within it. After remaining from fifteen to twenty days in the dogs' intestinal canal, these scolices, which when administered were without joints, exhibited a two-jointed body. After twenty-two days, the body was divided into three joints, and from this time forward these little tape-worms ceased to increase in length, or to become further divided, whilst the sexual organs began to appear in the two posterior of the three articulations. The development of the eggs in the sexual organs of these little worms was to be seen twenty-six days after the feeding, and the embryo appeared on the twenty-seventh day.

With the maturity of their sexual organs, and the division of their body into three joints (and hence with the production of only two *Proglottides*), I concluded these worms had attained their perfect state) from the circumstance that amongst the three-jointed little tape-worms in the dogs' small intestine, I discovered several individuals which had already, twenty-seven days after the feeding, thrown off the circlet of hooks. The loss of this apparatus amongst *Tæniæ* furnished with it, is a proof of mature age. When I endeavoured to determine the systematic position of the tape-worms which had been developed from the scolices of the *Echinococcus vete-*

rinorum and which did not exceed one, or one and a half lines in length, there was not a single species of *Tæniæ* among the many admitted by helminthologists, with which they agreed. I was soon convinced that this small species of tape-worm had been hitherto overlooked by helminthologists; for it cannot but be admitted that this transformation of the young of the *Echinococcus* into sexually-matured *Tæniæ* may take place independently of artificial feeding. In our slaughter-houses, similar scolices must certainly often find an opportunity of entering into the intestinal canal of dogs, the *Echinococcus*-vesicle, cut out of the viscera of the slaughtered animals and thrown away, being no doubt frequently devoured by the former. It was such a brood of *Tæniæ* developed from the young of the *Echinococcus* that Rudolphi probably saw, when he believed that he had discovered in the intestine of a dog, young tape-worms, which were assumed to have been developed by equivocal generation from the villi of the mucous membrane.[1] The little three-jointed tape-worms which Röll twice found in dogs, and which were not long ago described by him as young individuals of *Tænia serrata,* must also of a certainty have owed their origin to scolices of the *Echinococcus veterinorum.*[2]

The specific form of the hooks of the circlet of the scolices of the *Echinococcus veterinorum,* as well as the very small number of *Proglottides* generated by them, justify me in considering the *Tæniæ* developed from these scolices as a distinct species, which I have denominated *Tænia echinococcus.* (See the 'Zeitschrift für Wiss. Zool.,' B. IV, 1853, p. 423).

If we sum up the results of these experiments on feeding with *Echinococcus veterinorum,* they may be shortly stated as follows:

1. Sexually-developed *Tæniæ* have been produced out of all those kinds of scolices known as cystic worms which have been employed for feeding experiments.

2. From the scolices of the *Cysticercus pisiformis, tenuicollis, cellulosæ,* and *Cœnurus cerebralis, Tæniæ* of an ell long have been produced, which perfectly agree with both the *Tænia serrata,* and with the *Tænia solium.*

[1] See his 'Entozoorum sive vermium intestinalium historia naturalis,' vol. i, 1808, p. 411.

[2] See Röll's 'Beitrag zur Entwickelungsgeschichte der Tænien,' in theVerhandlungen der Physikal. Medizinischen Gesellschaft in Würzburg,' Bd. iii, 1852, p. 55.

3. The scolices of the *Echinococcus veterinorum* developed themselves into very small tape-worms, of from one, to one and a half, lines long, which have been shown to be a distinct species, and named *Tænia echinococcus.*

It may seem questionable to many helminthologists and zoologists, that four different kinds of cystic worms, which have hitherto been looked upon as so many distinct species, should only produce one and the same species of *Tæniæ*. But I would ask, are the cystic worms which have been termed *Cysticercus pisiformis, tenuicollis, cellulosæ,* and *Cœnurus cerebralis,* really distinct kinds? After the present inquiries, this question must be negatived. All these cystic worms are only the degenerated embryos and scolices of a single species of *Tænia.* If they who have always regarded these cystic worms as belonging to different species will make the experiment for themselves of detaching the several heads of the four above-named cysticerci, and mixing them together, they will find it utterly impossible to make out any specific difference between them. Further than this, I not only question if the *Tænia serrata* from the intestine of the dog, and the *Tænia solium* from the human intestine are distinct and sharply defined species, (see p. 68), but I also doubt the specific distinctness of the *Tænia marginata* from the intestine of the wolf, of the *Tænia crassiceps* from that of the fox, and of the *Tænia intermedia* from the intestine of martens and polecats. All these five *Tæniæ* certainly belong to but a single species of tape-worm, and only present varieties of race dependent on the influence of the varying circumstances to which the young *Tæniæ* are exposed in the course of their further development, according as they have entered the digestive canal of a man, a dog, a wolf, or any musteline carnivore. If we consider the diagnoses of these five kinds of *Tæniæ* given by helminthologists, we shall be convinced that there is not a single specific mark of distinction to be found between them, and that the form and arrangement of the circlet of hooks of these tapeworms are entirely disregarded. If the heads of the five above-mentioned, so-called species of tapeworm, with their circlet of hooks were submitted to the inspection of the most experienced helminthologist, without betraying their origin to him, I feel persuaded that he would be perplexed in distinguishing those five species of *Tæniæ,* which only differ according to their various habitations. In the genera *Ligula, Schistocephalus, Tetrarhynchus,* and *Echinorhynchus,*

helminthologists have long ago observed that certain species inhabit and attain sexual maturity in the most different kinds of birds and fishes. The conditions of life of the five races of degenerated *Tæniæ serratæ* (with their various œdematous forms of scolex, which are also to be considered as varieties of race), were certainly originally more simply and sharply defined, and must have gradually become impressed with their present complex and indefinite character from the domestication of the animals they infest.

At the same time, the results of these feeding experiments, which I have just cited, contradict the belief that the cysts of these worms have a physiological,[1] and not a pathological signification, for all the *Cystica* mentioned are produced from a single species of tape-worm, namely, the *Tænia serrata,* and it only depends upon the nature of the spot to which these embryos have been transplanted after having completed their immigration, whether they degenerate into *Cœnurus cerebralis,* or *Cysticercus pisiformis,* or *tenuicollis,* &c. When subject to the same external influences, these degenerations will always present the same form; whence it seems justifiable to compare these continually recurring and sharply-marked modes of degeneration of certain intestinal worms with the phenomena of race.

5. ON THE DISEASES PRODUCED BY CYSTIC WORMS, AND THEIR PREVENTION.

After having pointed out, in the introduction, that all the intestinal worms reach the interior of their hosts by immigration, and after having shown by the feeding-experiments, that certain cystic worms are transformed in the digestive canal of dogs into a particular kind of tape-worm, I may be allowed to draw the conclusion that, reversing the circumstances, the young of these tape-worms may, by the help of the alternation of generations which I have already described, be developed into cystic worms, the species of the animals and also the nature of the organs, into which the immigration takes place, exercising a specific influence

[1] Küchenmeister has taken much pains of late to defend this view, in opposition to mine, and has been led away by his zeal, to depart from that calmness of tone which becomes scientific controversy.

on the development and form of the cystic worms, and giving rise to many kinds of distinct degenerations (races).

By keeping in view these highly interesting vital conditions of certain intestinal parasites, we shall be enabled to take more efficient means against the spread of cestoid and cystic worms, in those cases in which their presence is prejudicial to the animals they inhabit, than could be the case so long as no one was aware in what way these parasites, whose entrance it was so desirable to prevent, made their way into the creatures they infested.

What purposeless and useless remedies have been proposed for this same worm-disease, we gather, amongst other things, from the numerous treatises which the disease of the "staggers" in sheep has called forth. On account of not having a correct acquaintance with the natural history of the *Cystica*, there necessarily arose the most contradictory and unreasonable opinions, and upon these a series of prophylactic and curative measures have been founded, which, resulting in no success, have been one after another discarded again. Amidst such irrational proceedings, we cannot blame the sheep owners if they entirely gave up using means for the eradication or prevention of the staggers, and unwillingly submitted to a loss that, amongst rich flocks, was by no means to be lightly estimated, amounting in many sheep-farms to more than ten per cent.

Were I to bring forward all the various causes to which the origin of the *Cœnurus* has been referred, I should far exceed the limits that I have assigned myself in these pages. That the doctrine of equivocal generation played a conspicuous part therein will surprise no one, since there yet exist veterinary surgeons who adhere to that doctrine in all points.

The only mode of insuring the destruction and removal of the worm, and hence the only effectual cure for the disease of the staggers, is trepanning. Unfortunately this process is not applicable in all cases—since it depends upon the situation of the worm, whether it can or cannot be reached by trepanning. The operation is of course admissible only when the *Cœnurus cerebralis* is imbedded in the anterior and upper portion of the ruminant's brain, whilst if, on the other hand, it be deeply seated in the base of the brain, or in the spinal marrow, it cannot be reached by trepanning. For this reason the testimonies as to

the result of this operation vary so widely. Operators who have accidentally fallen in with cases where the *Cœnuri* were superficially situated, have been successful, and so have gained credit, whilst other cases have completely baffled them. Not only the deep-seated position of the *Cœnurus cerebralis* occasions the ill success of the operation, but even postponing it so long that their size is already so great as to have produced much disturbance in the efficiency of the brain, may render the removal of the worms useless. Further, trepanning may also have come into discredit as an inefficient means of cure for the staggers, from having been applied on the appearance of dizziness which had been produced by other causes than the existence of a *Cœnurus cerebralis.*

Here I cannot refrain from remarking, that in the south of Germany, namely, in the Suabian part of the kingdom of Bavaria, the *Cœnurus cerebralis* not unfrequently appears in oxen; whilst in the north of Germany this disease is scarcely known in cattle. The common occurrence of the staggers amongst these domestic animals is probably the reason why trepanning has been recently tried as a cure for calves affected with the staggers. I have to thank Dr. Gierer, the provincial veterinary surgeon at Türkheim, who has performed the operation with success on several oxen, for his very interesting communications on this subject, amongst which the following points appear particularly worthy of notice.

M. Gierer is persuaded that the disease of the staggers amongst oxen is by no means of very unfrequent occurrence, but as hitherto no certain means of cure has been found for this evil, all the calves affected with the disease have been sold betimes to the butchers. Even M. Gierer, before he succeeded in curing by the trepan, had heard remarkably little in his own circle of the appearance of this disease amongst oxen; now, however, after having thoroughly cured eight and twenty oxen out of thirty which he trepanned, he is able to form some idea of the frequency of the complaint amongst the animals, being consulted oftener than ever about the cure of this disease.

I have compared several examples of *Cœnurus cerebralis* which Gierer obtained by trepanning from young oxen, mostly of from about two to three years old, with the *Cœnurus cerebralis* of sheep, and have found no specific difference between the two; so that I conclude that the *Cœnurus* of the ox also originates in the

Tænia serrata. Beyond this, the cysts of these *Cœnuri* were of extraordinary dimensions, since they would have exceeded the size of hens' eggs if, when in a fresh condition, they had been filled with water. They, moreover, contained a remarkable number of scolex gemmæ, which covered the interior surface of the cyst in masses thickly pressed together. Very many of the already developed scolices were everted, so as to project considerably on the exterior surface of the parent cyst, a phenomenon which I have seldom observed in those of sheep.

Although the fact has been proved, that the disease of the staggers, arising from the presence of *Cœnurus cerebralis*, can be cured by trepanning, still sheep-owners must not always reckon upon the absolute success of the operation, since, as has been already stated, the result must depend upon the situation of the parasite; and as it is impossible to know if two, or even several cysts, may not have established themselves at the same time in the nervous centres of the affected animal, of which one alone could be removed by trepanning, and that the cyst which lay nearest to the surface. Furthermore, even though the animals can be cured by the removal of these parasites, the question arises, if such animals, the vital powers of whose brain have been disturbed by the presence of this cyst, can be said to be cured in the full meaning of the word? Do the diseased changes which a considerable-sized *Cœnurus*-cyst engenders, through displacement, pressure, and wasting away of the substance of the brain, become so entirely removed after the extraction of the worm, that the vital powers of the brain can be again restored in their full integrity? Will there not still remain traces of changes engendered by the disease in such a brain, which although causing no striking interruption of the animal's nervous energies, may yet more or less affect its strength, duration of life, and fruitfulness, and render it inferior to a thoroughly healthy individual of the same race.

From what has been stated, it follows that the cure of the staggers, when it has once broken out, is always a difficult, and very often an impossible task; hence it would be much more worth while to take precautions for preventing it. The only rational prophylactic treatment must consist in employing such means as may prevent the immigration of the young of that tapeworm from which the *Cœnuri* are developed. As, according to my experiments, the *Cœnurus cerebralis* changes, in the digestive canal

of dogs, into the *Tænia serrata,* I venture to assume that the young of this tape-worm, after its immigration into ruminants, becomes developed in their nervous centres into the *Cœnurus cerebralis,* which, according to the situation it occupies, produces either vertigo by pressure upon the brain, or the phenomena characteristic of pressure upon the spinal marrow.

The *only prophylactic measure* against the morbid conditions induced by the *Cœnurus cerebralis* must therefore be—*to guard against the immigration of the young of the Tænia serrata.*

It will possibly be objected that, even if the generation of the *Tænia serrata* out of the scolices of the *Cœnurus cerebralis* had been proved, the production of the *Cœnurus cerebralis* from the young of the *Tænia serrata* must first be demonstrated, in order that, from the facts before us, we may have the right to consider immigrated young *Tæniæ* as the cause of the staggers proceeding from *Cœnurus cerebralis.* The laws of propagation of these animals long since suggested the view I have just put forth, but recently I have been put in possession of facts which directly support it. Dr. Haubner, professor at the veterinary school in Dresden, has in fact had the goodness to communicate to me that in that establishment, on the 7th of January of this year, several lambs were fed with perfect joints of the tape-worm of dogs, containing ova, and that on the 20th of January the first appearances of the staggers manifested themselves at the same time in all, whilst the remaining animals of the flock to which those lambs belonged continued healthy. The diseased lambs were killed and examined in succession at intervals of eight days, by which proceeding Professor Haubner obtained the following results:[1]

"At the commencement of the disease various symptoms of irritation and inflammation of the brain appeared, which perfectly accorded with those which Dr. Haubner had already become fully acquainted with in cases of the so-called spontaneous development of this disease. In this stage the sheep might either die, or else the irritation of the brain might pass away, and the *Cœnurus*-cysts proceed to further development. Upon dissection after three or four days, reckoning from the first appearance of the disease, Dr. Haubner found many cysts in the

[1] A short communication upon this subject has just been made by Professor Haubner to 'Hamms Agronomische Zeitung,' 1856, No. 10, p. 157.

brain, about the size of a pin's head. They lay partly free on the vessels in the convolutions of the brain, partly imbedded in superficial canals formed of exuded matter, the substance of the brain representing the bottom, and the exuded matter the covering of the canals. The whole animal (heart, lungs, muscles, &c.) was at the same time permeated by the encysted young of the tape-worm. Later dissections showed fewer but larger cysts in the brain. Mr. Haubner conjectures, and rightly so, that the rest were abortive and died away. After fourteen days, always reckoning from the first morbid symptoms, the same observer discovered several dark spots in a few of the cysts, which were probably the projected heads. After four weeks all the cysts had separate heads with distinct suckers; and, as it appeared, with the circlet of hooks in course of development."

After having thus proved by facts that the immigrated young of the *Tænia serrata* in ruminants can develope into *Cœnurus cerebralis*,[1] I feel justified in advising, as the most important preservative against the *Cœnurus*, that the immigration of the young of the *Tænia serrata* into ruminants should be prevented. The utility of this advice will certainly be admitted by every one who has made himself acquainted with the history of the intestinal worms in the foregoing pages of this pamphlet; but beyond this, persons will be also desirous of knowing how it can be practically carried out. When I consider the many hidden paths by which most of the intestinal worms make their way during their existence, I must confess once more that it will be a most difficult task for those engaged in the breeding of cattle to prevent the excessively small young of the tape-worm from passing into their oxen and sheep.

It may be safely assumed that the young of the tape-worm pass with the food into the digestive passages of the ruminants whilst they are eating and drinking. How easily the fresh as well as the dry fodder of ruminants may become contaminated with the ordure of dogs containing eggs of the *Tænia serrata;* especially when we remember that these eggs possess great tenacity of life, and are able to withstand for a considerable time external injurious influences, such as cold, heat, drought, &c.

[1] Through the kind communication, by letter, of Professor Leuckart, of Giessen, I have just heard that he has succeeded in generating the *Cysticercus fasciolaris* in the livers of white mice, after having given them sexually developed joints of the tape-worm of the cat (*Tænia crassicollis*) to eat.

If we fix our attention upon sheep, which are unfortunately too often exposed to the dangerous attacks of the *Cœnurus cerebralis,* we shall find that very frequently when a flock of sheep is attacked by the *Cœnurus cerebralis,* it is the sheep-dog who has guarded them year after year who is answerable for the mischief; in this case the shepherd's dog is infested by the *Tænia serrata,* whose young, after being passed by the dog in the neighbourhood of the flock, are easily caught up and swallowed by one sheep or another without being observed. The surest means, then, of keeping off the *Cœnurus cerebralis* from a flock of sheep would be to do away with the sheep-dog. To this, however, the sheep-breeders would hardly agree, since the services of a first-rate sheep-dog are not to be easily replaced by any other kind of help. But that the sheep-dog is really concerned in the devastations which the *Cœnurus cerebralis* makes in a flock is borne out by the fact that those sheep-flocks which, in the true sense of the word, are stall-fed, and consequently unattended by a dog, are never, or at least very rarely, troubled with the *Cœnurus cerebralis.* Those sheep-breeders who are disinclined to give up keeping dogs to guard their flocks, could urge as an objection that their dismissal would afford no sure guarantee for keeping off the parasite, inasmuch as the pastures where the sheep feed might become contaminated by the young of the *Tænia serrata* through other dogs, such as hounds and mastiffs; perhaps, indeed, even by wolves, foxes, or martens, and other animals of prey (see page 76).

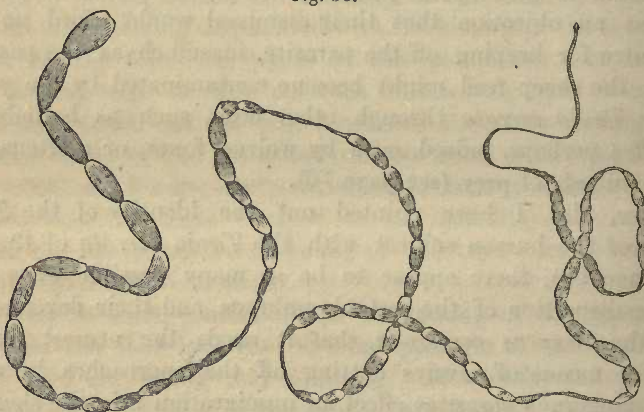
Since, also, I have pointed out the identity of the *Tænia solium* of the human subject with the *Tænia serrata* of the dog (see page 68), there appear to be so many possible ways open for the dispersion of the cestoid embryos and their development into the *Cœnurus cerebralis,* that it needs the utmost care to discover means of always cutting off the approaches by which these dangerous parasites effect an immigration into the sheep.

If, after these objections, which I have myself raised, I am the less inclined to think that the doing away with the sheep-dog would be an absolute preventive against the *Cœnurus cerebralis,* yet, I at least believe that, as a rule, and as a wise precaution, it might be recommended to those sheep-owners who employ dogs in the care of their flocks, to exercise a watch over them. If the dog be troubled with the *Tænia serrata,* the worm should be expelled before the animal comes in

contact either with the flock or their food. This supervision of the dog will be continually necessary, since although, according to my experience, the period of the parasite's existence is confined to only a few weeks, the opportunity for its immigration into the dog may frequently occur again. For the rest, I have pleasure in thinking that I have pointed out the true cause of the origin of the *Cœnurus cerebralis,* and hinted to the sheep-breeders in what way the worm creeps into their flocks; and I now leave it to intelligent proprietors to employ those means which are best fitted for the purpose of arresting the enemy, according to the locality, the style of farming, or to the condition of the animals. Having furnished a statement of the natural history of the *Cœnurus cerebralis,* I must leave it to experience to show if there are really means of preserving a flock of sheep from this cestoid parasite, and if so, what kind of means.

The *Tænia serrata* of the dog, whose presence in the sheep-dog is most particularly to be guarded against, is easily distinguishable from the other, harmless, tape-worm of the same animal,

Fig. 36.



the *Tænia cucumerina*; the first having its developed joints always white, and of a quadrangular or oblong shape, with only a single irregular marginal sexual aperture, varying in its position on each, whilst the developed joints of the *Tænia cucumerina* are elliptical

Fig. 36. *Tænia cucumerina,* from the intestines of a dog, with perfectly developed joints, natural size.

in form, are commonly of a pale-red colour, and have on every joint two marginal apertures opposite to each other.

The evidence that I have given in the foregoing chapter of certain cestoids becoming changed in the digestive canal of dogs into sexually developed tape-worms, suggests the idea that, most probably, the greater number of the human tape-worms enter as scolices into the intestine of man. That the opportunity for such an immigration may readily occur is plain, if we reflect how easily a *Cysticercus* may get upon the lips of a butcher or a cook in handling pork containing these parasites. In fact, it appears from the medical reports that persons engaged in slaughter-houses and kitchens very commonly suffer from tape-worms,[1] which indicates that, although the use of "measly" meat for the most part never produces dangerous results, yet that especial care should be taken regarding it. In any case, encysted pork, when boiled or roasted, can afford no opportunity for the production of a *Tænia solium* in the human digestive canal, since the *Cysticerci* will be completely destroyed by the degree of heat necessary for the preparation of the meat; but it is quite a different case with smoked sausages, in the manufacture of which many butchers make use of measly meat.[2] With the present clever and expeditious method of smoking them, how easily may a sausage stuffed with this meat be eaten so soon and in such a fresh condition, that one or another scolex may have preserved its vitality, and awakening from its trance in the human digestive canal, proceed to its development as a tape-worm. From what I have stated in the earlier chapters with regard to the internal relation of the scolices to the tape-worms, it is now explained how that in no country are men more tormented by these parasites than in Abyssinia, it being well known that the Abyssinians eat a great deal of raw meat. Dr. Bilharz, formerly a pupil of mine, some time ago wrote to me from Cairo, that in Abyssinia the tape-worm was so common that a native would regard it as an abnormal condition if he were to expel no tape-worm joints; and that no slave was purchased there without at the

[1] Compare Wawruch, 'Praktische Monographie der Bandwurmkrankheit,' Vienna, 1844, p. 197.

[2] The shrunk *Cysticerci* in such sausages are very easily to be found; they form milk-white bodies of the size of a needle's head, which, when pressed between glass plates and seen through the microscope, show the circlet of hooks and the four suckers of the scolex very distinctly.

same time receiving a packet of cusso to remove his tape-worm. That the flesh of our cattle affords the principal opportunity for the immigration of the *Tænia solium* into man, is borne out by the experience of Reinlein,[1] a physician of Vienna; who for ten successive years professionally attended the Carthusian monks, who never partake of either meat or milk, but live mostly on fish; he had never seen a single person who had suffered from tape-worms, and was assured by the oldest fathers that they never remembered any of their associates to have been troubled with them.

But it is not alone in the torrid and temperate zones of our globe that man is visited by these parasites, for even in the polar regions the cestoids find means of reaching him. Dr. Schleisner, who a few years ago published a medical topography of the island of Iceland,[2] makes mention of an epidemic liver complaint or hydatid disease which made great ravages among the Icelanders. In the short account of this complaint, which is more commonly met with in the interior of the country than on the coast, I recognise a tape-worm which is imbedded not only in the livers, but also in the abdominal organs and in the skin of these islanders. Professor Eschricht, of Copenhagen, wrote to me lately that the sixth part of the whole population of Iceland suffered from this disorder of the liver, and that with many of them, after dreadful and protracted sufferings, it terminates in death. From a more particular description and illustration of this disease produced by the tape-worm, for which I am indebted to the kindness of Eschricht, I conclude that the parasite is one of the *Cysticerci*, and has its origin in the *Tænia serrata* (*solium*). In Copenhagen, people's attention has already been drawn to this cestoid disease, so highly fatal to the Icelandic population, and they appear to be desirous of taking energetic measures for its prevention. I entertain the belief that, bearing in mind the natural history of the *Cysticerci* as I have represented it in these pages, it may be possible to prevent the immigration of the cestoid young—to which, from the Icelanders' mode of life, they

[1] See his 'Bemerkungen über den Ursprung, die Entwickelung, die Ursachen, Symptome und Heilart des breiten Bandwurmes in den Gedärmen des Menschen,' Vienna, 1812, p. 25.

[2] See his 'Forsög til en Nosographie of Island,' Kjöbenhavn, 1849 A short abstract of this work will be found in 'Janus,' the 'Central-Magazin für Geschichte und Literär-Geschichte der Medizin,' vol. i, 1851, p. 300.

are so fatally exposed—into the inhabitants of this island. How this may be effected the following remarks may serve to show. It is well known that the Icelanders carry on an extensive breeding of cattle and sheep, in which the canine race are in many ways serviceable.[1] I presume that the Icelanders, when slaughtering their cattle, never have the dogs far off, and thereby it readily happens that these voracious animals, in swallowing what is thrown aside, take in various *Cysticerci;* from these the *Tænia serrata* is developed, and their young, by means of the oxen, give rise to many evil consequences to man. If the dogs of the Icelanders were kept under supervision and free from the *Tænia serrata,* not only would the propagation of the young of this tape-worm be certainly prevented, but also their immigration into man and cattle, and their injurious degeneration into *Cysticerci.*

It can now be no longer regarded as wonderful, or considered as fabulous, when physicians inform us that after raw meat had been prescribed for certain of their patients, they had found them to become troubled with tape-worms.[2] In the cases that were met with, it was explicitly said to be the *Tænia solium* that was expelled, which exactly supports the opinion that this tape-worm, so rare in St. Petersburg, has there been developed by the adoption of a diet of raw meat. The statements would have been much more to be suspected if, in the tape-worms that were passed, the *Bothriocephalus latus,* so general in Russia and Poland, had been recognised, since this worm is never met with amongst our cattle in a scolex condition. Formerly, the geographical distribution of both these human tape-worms, the *Bothriocephalus*

[1] What important services the numerous dogs spread all over Iceland render to the inhabitants in their husbandry, is given in the more or less detailed accounts of travellers. Compare Hornebow, 'Zuverlässige Nachrichten von Island,' Copenhagen, 1753, pp. 143 and 164; further, Hooker, 'Journal of a Tour in Iceland in the Summer of 1809,' London, 1813, vol. i, p. 339.

[2] Compare, upon this subject, the communications made by Weisse (in the 'Journal für Kinderkrankheiten,' vol. xvi, 1851, p. 384), which, in spite of Braun's objections (ibid., vol. xviii, 1852, p. 78; or in Froriep's 'Tagesberichten,' 1852; 'Geburtshülfe und Kinderkrankheiten,' p. 281), are worthy of all belief. The opinion expressed by Andral in favour of the doctrine of equivocal generation ('Grundriss der pathol. Anatomie,' Leipzig, vol. i, p. 393), that from external mechanical influences (a contusion) affecting an organ, its necessary nourishment may be disturbed, so that the organic particles are not fully assimilated, and become metamorphosed into lower kinds of animals (into a *Cysticercus*)—an opinion in which Professor Uhde, of Brunswick, also coincides (see 'Deutsche Klinik.,' 1851, No. 40, p. 434)—is thus thoroughly refuted.

latus and the *Tænia solium,* was declared to be very sharply defined; the appearance of the former being supposed to be confined to Switzerland, Poland, and Russia; but now, if the *Tænia solium* were to show itself in these countries, it would not be a matter of astonishment nor appear unworthy of belief, since, through the importation of cattle infested with *Cysticerci,* from countries where only the *Tænia solium* is found, this tape-worm may easily be introduced in its scolex form.[1]

After this statement of the history of the tape-worms, and of the *Cysticerci* which stand in such close relationship with them, I trust that I may have so strongly shaken the many false views and prejudices so deeply rooted amongst physicians, veterinarians, and economists, with regard to the origin, development, and propagation of these intestinal worms, that they may henceforth be renounced as untenable. I have thereby not only the satisfaction of having uprooted the very foundations of a *château en Espagne,* filled with the most marvellous hypotheses, but of having erected in its place a structure compacted of facts and based upon experimental demonstrations, which throw a light upon a path hitherto wrapped in profound obscurity, but which may now be profitably followed.

[1] According to a written communication, for which I am indebted to Dr. Baumert, during his stay in Neuchatel, the *Cysticerci* are almost unknown in pigs in the western parts of Switzerland, viz., in Neuenburg, whilst all those pigs that are introduced there from France are abundantly infested with them.

INDEX OF TAPE AND CYSTIC WORMS.

LIST OF THE WORKS PUBLISHED BY THE SYDENHAM SOCIETY FROM ITS FOUNDATION IN 1843,

IN THE ORDER IN WHICH THEY WERE ISSUED.

FOR THE FIRST YEAR, 1843-4.

* "*Hecker's Epidemics of the Middle Ages.*" 1 vol., 8vo, pp. xx, 380.
* "*Louis on Phthisis.*" 1 vol., 8vo, pp. xxxv, 571.

"*Th. Sydenham Opera Omnia.*" 1 vol., 8vo, pp. xxx, 668.

FOR THE SECOND YEAR, 1844-5.

* "*The Seven Books of Paulus Ægineta.*" Vol. I, pp. xxviii, 683.
* "*Observations on Aneurism.*" 1 vol., 8vo, pp. xii, 524.
* "*Simon's Animal Chemistry.*" Vol. I, 8vo, pp. xx, 360, plate.

FOR THE THIRD YEAR, 1845-6.

* "*Simon's Animal Chemistry.*" Vol. II, 8vo, pp. xii, 560, 2 plates.
* "*Paulus Ægineta.*" Vol. II, 8vo, pp. xi, 511.

"*Hasse's Pathology.*" 8vo, pp. xvi, 400.

FOR THE FOURTH YEAR, 1846-7.

"*The Works of W. Hewson.*" 1 vol., 8vo, pp. lvi, 360, portrait and 8 plates.

"*Dupuytren's Lectures on Diseases and Injuries of Bones.*" 1 vol., 8vo, pp. xvi, 459.

"*The Works of W. Harvey, M.D.*" Complete in 1 vol., 8vo, pp. xcvi, 624.

FOR THE FIFTH YEAR, 1847-8.

* "*Paulus Ægineta.*" Vol. III, pp. viii, 653.

"*Feuchtersleben's Medical Psychology.*" Pp. xx, 392.

"*Microscopical Researches of Schwann and Schleiden.*" Pp. xx, 268, 6 plates.

"*Memoirs of the French Academy of Surgery.*" Pp. x, 293.

FOR THE SIXTH YEAR, 1848-9.

"*Rhazes on the Smallpox and Measles.*" 8vo, pp. viii, 212.

"*The Genuine Works of Hippocrates, translated from the Greek.*" Vol. I, 8vo, pp. x, 466.

"*The Works of Sydenham, translated from the Latin.*" Vol. I, 8vo, pp. cvi, 276.

"*Rokitansky's Pathological Anatomy.*" Vol. II (the first issued), 8vo, pp. 375.

FOR THE SEVENTH YEAR, 1849-50.

"*The Genuine Works of Hippocrates.*" Vol. II, pp. 406.

"*Essays on the Puerperal Fever, and other Diseases peculiar to Women.*" 8vo, pp. 552.

"*The Works of Sydenham, translated from the Latin.*" Vol. II, pp. 396

FOR THE EIGHTH YEAR, 1850-1.

"*Rokitansky's Pathological Anatomy.*" Vol. III, 8vo, pp. xvi, 467.

"*Hunter on the Gravid Uterus.*" 1 vol., folio, 34 plates, with descriptive letter-press.

FOR THE NINTH YEAR, 1851-2.

"*Unzer and Prochaska on the Nervous System.*" 1 vol., pp. xvi, 463.

"*Annals of Influenza.*" 1 vol., pp. xvi, 406.

'*Rokitansky's Pathological Anatomy.*" Vol. IV, pp. x, 398.

FOR THE TENTH YEAR, 1852-3.

"*Romberg on Diseases of the Nervous System.*" 2 vols. Vol. I, pp. xvi, 368; Vol. II, pp. viii, 450.

"*Kölliker's Manual of Human Histology.*" Vol. I, woodcuts, pp. xix 498.

FOR THE ELEVENTH YEAR, 1853-4.

"*Kölliker's Manual of Human Histology.*" Vol. II, woodcuts, pp. x, 434.

"*Rokitansky's Pathological Anatomy.*" Vol. I, 2 plates, pp. xvi, 446.

"*Dupuytren on Lesions of the Blood-vessels,*" &c. 1 vol., pp. 378.

FOR THE TWELFTH YEAR, 1854-5.

"*Wedl's Pathological Histology.*" 1 vol., woodcuts, pp. xxvi, 637.

"*Oesterlen's Medical Logic.*" 1 vol., pp. xii, 437.

FOR THE THIRTEENTH YEAR, 1855-6.

"*Velpeau on Diseases of the Breast.*" 1 vol., pp. xxiv, 608.

"*The Works of Aretæus,*" Greek and English. 1 vol. pp. xx, 510.

FOR THE FOURTEENTH YEAR, 1856-7.

"*Von Siebold and Küchenmeister on Intestinal Worms and other Parasites.*" 2 vols., 8vo, with numerous illustrations, plain and coloured. Pp. xix, 492—xvi, 287—xx, 88.

*** *Those books to which an asterisk is affixed are out of print; of the others copies are still on hand, and may be had at reduced prices on application at* 45, FRITH STREET, SOHO.